United States Court of Appeals

for the Second Circuit

APPENDIX

75-6115

76-6022

IN THE UNITED STATES COURT OF APPEALS
FOR THE SECOND CIRCUIT

Docket Nos.
75-6115
76-6022

B

THE STATE OF NEW YORK,

Plaintiff-Appellant,

-against-

THE NUCLEAR REGULATORY COMMISSION, et al.,

Defendants-Appellees.

ON APPEAL FROM THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF NEW YORK

JOINT APPENDIX
VOLUME II

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UNITED STATES COURT OF APPEALS
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SECOND CIRCUIT

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TABLE OF CONTENTS

Volume I	Appendix Page
List of Docket Entries.	1
Motion For Preliminary Injunction	
Summons.	5
Complaint.	7
Affidavit - John F. Shea, III, sworn May 2, 1975.	122
*Supplemental Affidavit - John F. Shea, III, sworn May 2, 1975.	929
Affidavit - Peter N. Skinner, sworn April 29, 1975.	128
Affidavit - Dr. Marvin Resnikoff, sworn April 25, 1975.	143
*Supplemental Affidavit - Peter N. Skinner, sworn May 2, 1975.	934
Order To Show Cause dated May 6, 1975.	174
Transcript - May 7, 1975, Before Hon. William C. Conner.	177
Defendants' Affidavits in Opposition To Motion For Preliminary Injunction	
Affidavit - Charles Richter, sworn May 30, 1975.	211
Affidavit - Lee V. Gossick, sworn May 29, 1975.	215

* Items marked by asteriks were sealed at the request of parties during the proceedings below by the District Court and are contained in Volume III of this Appendix which should be similarly treated as sealed.

Appendix Page

Affidavit - Frank K. Pittman, sworn May 29, 1975. 232

Affidavit - Leland C. Rouse, sworn May 29, 1975. 236

Affidavit - Joseph V. Catania, sworn May 29, 1975. 251

Affidavit - G. Wayne Kerr, sworn May 29, 1975. 255

Affidavit - Dixi Lee Ray, sworn May 28, 1975. . 268

Affidavit - Herbert H. Kaiser, sworn May 29, 1975. 275

Affidavit - Donald A. Nussbaumer sworn May 29, 1975 with Exhibits A, B and D. 286

Affidavit - Robert F. Barker, sworn May 30, 1975. 387

Affidavit - Ralph G. Page, sworn May 29, 1975. . 424

Affidavit - Ernest Graves, sworn May 29, 1975. . 577

Volume II
Plaintiff's Reply Affidavits on Motion For Preliminary Injunction

Affidavit - John F. Shea, III, sworn June 16, 1975. 580

Affidavit - Karl Z. Morgan, sworn June 6, 1975. 615

Affidavit - Irving Pinkel, sworn June 10, 1975. 619

Affidavit - Dr. John W. Gofman, sworn June 10, 1975. 640

Affidavit - Dr. Seville Chapman, sworn June 11, 1975. 698

Appendix Page

Affidavit - Dr. Marvin Resnikoff, sworn June 12, 1975. 705

Affidavit - Peter N. Skinner, sworn June 13, 1975. 712

*Affidavit - T. Mason and R. Leamer, sworn June 16, 1975. 949

Letter - Charles Richter to Hon. William C. Conner dated June 10, 1975. 743

Letter - John F. Shea, III, to Hon. William C. Conner dated June 24, 1975 with enclosure number 2 only. 745

Transcript - July 3, 1975, Before Hon. William C. Conner. 761

Letter - John F. Shea, III, to Hon. William C. Conner dated July 17, 1975. 788

Affidavit - Dr. John W. Gofman, sworn July 21, 1975. 790

Letter - Charles Richter to John F. Shea, III dated July 25, 1975. 831

Transcript - July 25, 1975, Before Hon. William C. Conner. 835

Transcript - July 31, 1975, Before Hon. William C. Conner. 865

*Affidavit - John F. Shea, III, sworn July 31, 1975. 984

*Affidavit - Peter N. Skinner, sworn July 31, 1975. 988

*Transcript - August 4, 1975, Before Hon. Charles E. Stewart. 992

Appendix Page

Transcript - August 20, 1975, Before Hon. William C. Conner. 875

Answer of Defendants (other than Civil Aeronautics Board ["CAB"] Robert D. Timm, U.S. Customs Service, Vernon B. Acree and Fred R. Boyett). 889

*Affidavit - Leo Macklin, sworn September 2, 1975. 1013

Order, William C. Conner, U.S.D.J., denying plaintiff's motion for preliminary injunction, filed September 9, 1975. 895

Notice of Appeal, filed November 7, 1975. . . . 912

Motion To Dismiss

Defendants' Civil Aeronautics Board and U.S. Customs service Notice of Motion, August 15, 1975. 914

Affidavit of John F. Shea, III, sworn September 5, 1975. 916

Appendix to Plaintiffs' Memorandum of Law in opposition to Defendants' Motion to Dismiss the Complaint, dated September 5, 1975. . . . 917

Order, William C. Conner, U.S.D.J., granting motion to dismiss complaint as to CAB and Customs Service, filed December 23, 1975. . . 922

Notice of Appeal, filed February 5, 1976. . . . 928

*Volume III

Supplemental Affidavit - John F. Shea, III, sworn May 2, 1975. 929

Appendix Page

Supplemental Affidavit - Peter N. Skinner, sworn May 2, 1975. 934

Affidavit - T. Mason and R. Leamer, sworn June 16, 1975. 949

Affidavit - John F. Shea, III, sworn July 31, 1975. 984

Affidavit - Peter N. Skinner, sworn July 31, 1975. 988

Transcript - August 4, 1975, Before Hon. Charles E. Stewart. 992

Affidavit - Leo Macklin, sworn September 2, 1975. 1013

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

----------X

THE STATE OF NEW YORK, :

Plaintiff, :

-against- : AFFIDAVIT

THE NUCLEAR REGULATORY COMMISSION, et al., : 75 Civ. 2121 (WCC)

Defendants. :

----------X

STATE OF NEW YORK)
: SS.:
COUNTY OF NEW YORK)

JOHN F. SHEA, III, being duly sworn, deposes and says:

1. I am an Assistant Attorney General in the office of LOUIS J. LEFKOWITZ, Attorney General of the State of New York. I submit this affidavit in support of plaintiff's motion for a preliminary injunction.

2. Submitted herewith are the affidavits of a number of expert individuals who have analyzed the issues involved with the air transport of special nuclear materials and the affidavits of the defendants submitted on May 30, 1975 in response to the request of the State of New York for a preliminary injunction against such transport.

3. Dr. Karl Z. Morgan, formerly with the Atomic Energy Commission as Director of the Health Physics Division of Oak Ridge National Laboratories for 33 years, explains why, on the basis of his experience with plutonium disasters and cleanup, he views plutonium and other actinide elements to be so dangerous as to warrant their total restriction to ground and water transportation. In so doing he endorses the statement of the Special Panel to Study Transportation of Nuclear Materials to the Joint Committee on Atomic Energy, Congress of the United States, in the September 17, 1974 Report, a copy of which is attached hereto as Exhibit "A". Dr. Morgan is a member of the Special Panel.

4. Irving Pinkel, flight safety and crash survivability analyst with 37 years of government service, including 32 years with NASA, NACA and the investigation of the Apollo fire and the Apollo 13 accident, expresses his view that the hazards and likelihood of breach in containment, as a result of realistic aircraft environments, are so severe as to presently warrant the utilization of only surface modes of transport and the termination of air shipments of special nuclear materials.

5. Dr. John W. Gofman, a licensed physician and nuclear chemist, former group leader of the Plutonium Project at Berkley, (1942-1944), a part of the Manhattan Project, concludes that, upon failure of a container of plutonium in an aircraft accident and subsequent dispersal, the risk of death to substantial numbers of persons would be exceedingly high. Specifically, he finds the threat of lung cancer due to plutonium exposure is 4045 times greater than that computed by the NRC (Barker). He calculates that, under case A of Dr. Resnikoff's plutonium dispersion hypothesis (affidavit sworn to April 25, 1975), all 8,000,000 people in New York City will die of lung cancer save for intervening causes of death. In an exhibit to his affidavit he presents an analysis of the gruesome death of an air freight handler who was fatally contaminated as a result of plutonium liquid being spilled on his finger.

6. Dr. Seville Chapman, director of the Cornell Aeronautical Laboratory for 22 years and a scientific consultant with the Office of Naval Research, Washington, finds that air transportation presents substantially greater risks of extremely high impacts on containers and resulting dispersion than do other modes of transportation.

7. Ted Mason and Robert Leamer, Commander and Lt. Commander respectively, with the U.S. Naval Reserve in the Mobile Inshore Undersea Warfare Unit are specialists in terrorist

techniques and counterinsurgency methods. They conclude that, on the basis of available data, special nuclear materials in commercial air transport through metropolitan areas are more susceptible to diversion and attack than such materials in the course of military surface transport. It is requested that their affidavit be sealed due to certain references to security procedures.

8. The affidavit of Dr. Resnikoff responds to the statements by defendants regarding his original breach of containment/dose analysis made in his affidavit sworn to April 25, 1975.

9. Peter N. Skinner, in one part of his affidavit, computes for the Court, as Mr. Barker failed to do, the number of deaths which, utilizing Mr. Barker's very own figures, would be caused by a dispersion of an air shipment of plutonium. Mr. Barker's figures can be seen to approximate those of Dr. Resnikoff.

10. The attention of the Court is directed to the Report annexed to this affidavit, as Exhibit "A" wherein the Special Panel to Study Transportation of Nuclear Materials to the Joint Committee on Atomic Energy makes certain recommendations with respect to the air transport of radioactive materials. On pages 13 and 14 the Panel recommended that the then AEC and DOT restrict other than exempt quantities of plutonium to surface transport despite the resultant increase in the time such materials would be in transit.

11. The United States Environmental Protection Agency, in a letter dated May 8, 1975, from Deputy Assistant Administrator Rowe to Lee V. Gossick, Executive Director of Operations of the NRC (copy attached as Exhibit "B") expresses the concern of the EPA regarding the shipment of plutonium and other special nuclear materials by commercial aircraft. The letter states in part:

"Since an aircraft accident involving plutonium could potentially lead to serious environmental and public health effects, we believe that steps should be taken to assure protection of the public health and the environment in conducting these shipping activities. Probably the most immediate problem lies in estimating the potential consequences of an aircraft accident occuring in a major metropolitan area, such as the New York City area.

We believe that before the commercial air transportation of plutonium becomes widespread, it would be prudent from a public health standpoint for NRC to examine the risk involved in such transportation in detail."

12. As can be seen in the affidavits of Dr. Morgan and Dr. Goffman the difficulties relating to decontamination and clean-up of areas exposed to plutonium dispersal are enormous. Upon information supplied by Melvin Carter and Bernd Kahn, both formerly with the United States Environmental Protection Agency (EPA) and presently Professors of Nuclear Engineering at Georgia Institute of Technology, the cost of clean-up at Palomares, Spain, after a non-nuclear explosion of plutonium weapons which resulted in dispersion, was several hundred million dollars. (Odland, et al., J. Occup. Med. 10, 356, 1968) The clean-up involved the removal of top soil from 5 1/2 acres of land and the stripping of vegetation from over 600 acres, all of which material had to be shipped to, and buried in the United States.

13. Immense clean-up operations were required at Thule, Greenland, after the crash of an Air Force bomber resulted in a similar disaster. A description of that clean-up is contained in an issue of "USAF Nuclear Safety" attached hereto as Exhibit "C". Plaintiff submits that clean-up operations for a metropolitan area, such as New York City or San Francisco, would be far more difficult than the clean-up of Palomares or Thule, in as much as those areas were strictly rural and more amenable to the stripping of top-soil, vegetation, snow and ice.

14. Defendants' representations regarding certain shipments of special nuclear material require clarification. G. Wayne Kerr at paragraph 15 of his affidavit, states that four shipments of plutonium, exported from J.F.K. Airport in 1974, "originated" from a storage facility owned and operated by the New York Atomic and Space Development Authority (ASDA), which he characterizes as an agency of New York State. It should be emphasized that, upon information and belief, ASDA (which is not an agency of the state, but a public benefit corporation) did not own that plutonium and did not ship it. The plutonium was actually owned by various public utility companies, a number of which are located out-of-state, and was merely stored by the utilities at the ASDA facility. Upon information and belief, the shipper had informed ASDA that it wished to transport the plutonium in a container of a particular design; ASDA accordingly gave notice to the federal government that this type of container would be used. Notice, rather than a request for approval, was sufficient here, since this specific type of container had been previously approved by the federal government up on the application of the General Electric Company.

Wherefore, Plaintiff respectfully requests that its motion for a preliminary injunction be granted in all respects.

JOHN F. SHEA, III

Sworn to before me this
16th day of June, 1975

Assistant Attorney General
of the State of New York

93d Congress
2d Session } JOINT COMMITTEE PRINT

TRANSPORTATION OF RADIOACTIVE MATERIAL BY PASSENGER AIRCRAFT

REPORT No. 1

OF THE

SPECIAL PANEL TO STUDY TRANSPORTATION OF NUCLEAR MATERIALS

TO THE

JOINT COMMITTEE ON ATOMIC ENERGY
CONGRESS OF THE UNITED STATES
NINETY-THIRD CONGRESS
SECOND SESSION

SEPTEMBER 17, 1974

Printed for the use of the Joint Committee on Atomic Energy

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Exhibit A

585

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SPECIAL PANEL TO STUDY TRANSPORTATION OF NUCLEAR MATERIALS

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WILLIAM WEGNER

(II)

985

MEMORANDUM OF THE CHAIRMAN AND VICE CHAIRMAN

On May 17,[1] we announced the selection of a special panel to study the transportation of nuclear materials from the standpoint of health and safety and the safeguarding of nuclear materials from the standpoint of loss and diversion. The first portion of this study which covers the transportation of radioactive material by passenger aircraft has been completed, submitted to the Joint Committee and is hereby published.

This effort was initiated to determine the adequacy of current regulatory provisions and practices to protect health and safety and to prevent diversion. The greatly increasing use of radioactive isotopes in medicine and industry makes such a review a matter of current importance. The increasing use of nuclear fuel for electric power generation will in a few years result in a significant increase in the flow of enriched uranium and plutonium in the commerce of our Nation which will require special efforts to assure protection against diversion and losses. Both the increasing use of such materials and the increased prevalence of terrorist activities which may become directed at the acquisition of enriched uranium and plutonium make it specially important that the proper safeguarding of such material be given attention.

The Joint Committee was most pleased to obtain the services of the following panel members:

Mr. John T. Conway (Chairman of the Panel) Executive Assistant to the Chairman of the Board of Consolidated Edison Company. Formerly Special Agent of the FBI and Executive Director of the Joint Committee on Atomic Energy. Mr. Conway is a lawyer and engineer.

Mr. Carmine S. Bellino, formerly Administrative Assistant to J. Edgar Hoover and in charge of the FBI's Accounting Unit. Mr. Bellino is a certified public accountant. He has performed a special survey of the safeguarding of nuclear materials for the AEC.

Dr. K. Z. Morgan, Professor, Nuclear Engineering Department, Georgia Institute of Technology, formerly Director of Oak Ridge National Laboratory, Health Physics Division (1943–72) and Cosmic Ray Physicist.

Mr. John G. Palfrey, Professor of Law at Columbia, formerly Dean, Columbia College, Atomic Energy Commissioner, Fellow Kennedy Institute of Politics at Harvard, and Chairman of the AEC's Advisory Committee on Nuclear Materials Safeguards.

Dr. Theodore B. Taylor, Chairman of International Research and Technology Corporation. Formerly consultant to International Atomic Energy Agency on international safeguards of

nuclear materials, Deputy Director, Defense Atomic Support Agency, and staff member of the Los Alamos Scientific Laboratory.

Mr. William Wegner, Deputy Director of Naval Reactors Division of AEC with special responsibilities in regard to nuclear materials.

Reports on other areas of the study will be published as they are completed. The Joint Committee thanks the panel for its dedicated efforts to date and looks forward to the receipt of their findings and recommendations in the remaining areas of their study.

The publication of this report at this time does not signify the Joint Committee's endorsement of the panel's findings and recommendations. The Joint Committee has not had an opportunity to study the report nor explore the areas and findings. Although the committee plans to review the panel's report in detail and explore the various factors involved in Joint Committee hearings, it did not wish to delay making available the panel's findings. Accordingly, the report is being published in advance of such a review to assure that the panel's independent study be made available without delay to all interested Members of Congress, Government, industry, and the public.

MELVIN PRICE, *Chairman*,
JOHN O. PASTORE, *Vice Chairman*.

LETTER OF TRANSMITTAL

SEPTEMBER 17, 1974.

Representative MELVIN PRICE, *Chairman*,
Senator JOHN O. PASTORE, *Vice Chairman*,
Joint Committee on Atomic Energy,
U.S. Congress, *Washington, D.C.*

DEAR MR. CHAIRMAN AND MR. VICE CHAIRMAN: Transmitted herewith is Report Number One from the Special Panel to Study the Transportation of Nuclear Materials pertaining to *Transportation of Radioactive Material By Passenger Aircraft*.

In your letter of May 30, 1974 to me, you advised that the Joint Committee was particularly anxious to know if any changes are needed at the present time and that you wished the panel to concentrate its efforts on determining what, if anything, is now being done incorrectly. You pointed out, that to be of greatest value, the results of our deliberations should be made available at an early date so that legislative action, if necessary, could be taken this congressional session.

As the panel delved into the current regulations and practices pertaining to the transportation of radioactive materials, it recognized that many problems are particular to the specific mode of transportation used and type of material being shipped. The use of passenger aircraft for transporting radioactive material appeared to be of particular importance at this time since it had become the subject of great concern to many, including aircarrier personnel, and strong efforts were being made by some concerned individuals to totally ban such shipments. As discussed with the committee, it was agreed that the panel should initially concentrate its efforts in reviewing the use of passenger aircraft for transporting radioactive material.

The enclosed report, while it does touch upon some other areas of concern, primarily pertains to the transportation of radioactive material by passenger aircraft. Further reports by the panel will discuss other areas of transporting radioactive material and will be submitted to you as completed.

Respectfully yours,

JOHN T. CONWAY,
Chairman, Special Panel to Study the Transportation of Nuclear Materials.

CONTENTS

	Page
Memorandum of the Chairman and Vice Chairman	III
Letter of transmittal	V
I. Introduction	1
II. Development of present regulations	3
III. Basis of panel's recommendation	4
IV. Discussion of findings and recommendations	6
A. Permissible radiation level to airline passengers and crew due to shipment of radioactive material in cargo spaces	6
B. Recommended modification in regulations for the shipment of radioactive material by passenger carrying aircraft to reduce exposures to members of the public and to occupational workers	8
Table 1. Radioactive material categories—Dose rate limits	9
C. Reducing the risks of radiation exposure and of environmental contamination	9
Table 2. Transportation of radioactive materials	10
D. Monitoring radioactive shipments	11
E. Transportation of plutonium by aircraft	13
F. Radioactive material packaging design review and approval	15
VI. Summary of major conclusions and recommendations	15
VII. Additional recommendations	16
Appendix A. List of individuals with whom panel has conferred	19
Appendix B. Letter dated May 30, 1974 relative to work in progress of the panel	21
Glossary	23

I. INTRODUCTION*

In 1973, an estimated 800,000 shipments of radioactive material were made in the United States, of which two-thirds—600,000—were made on passenger aircraft. Total shipments of radioactive materials are projected to reach 1 million for the year 1974 and to continue to increase significantly each year for the foreseeable future with passenger aircraft the predominant carrier.

Although some of the radioactive material in transit is related to industrial or research uses, the majority—more than 95 percent—of these shipped by air, are used in the medical profession. These medical isotopes mostly have short half-lives and to be effective must be transported relatively fast from pharmaceutical suppliers to hospitals and other locations for use by medical doctors. Because of their short half-lives, they must be regularly replenished, usually on a weekly basis.

The increasing use of radioisotopes—particularly by the medical profession—and the corresponding increase in the use of passenger aircraft for their transportation has caused some concern for the health and safety of the passengers and crew of the carrier aircraft as well as for the airline personnel who handle the cargo in transit. A number of known incidents—although very few in relation to total shipments—have occurred in which the transported radioactive material has breeched its container or has been improperly shielded by the shipper. These occurrences, some of which were not discovered until after receipt by the consignee, justifiably raise questions as to the adequacy of existing Government standards and enforcement of regulations for packaging and monitoring radioactive material in transit.

But beyond the concern over the potential hazard to the public and airline personnel from accidental release of radioactive material, infrequent as it may be, there is concern as to the radiation effects of this increasing amount of radioactive material being carried on passenger aircraft under normal conditions, i.e., where existing regulations have not been violated. This raises the question whether or not standards set by the Department of Transportation (DOT) and the Atomic Energy Commission (AEC) to regulate radioactive material in transit are sufficiently conservative in light of the growing number of such shipments and the increasing probability passengers and airline personnel will be exposed to low levels of radiation from these shipments. In other words, assuming full compliance with present regulations—which in actual practice the panel found one could not assume—are present regulations adequate to protect the public and transportation workers from radiation external to the package?

In assessing the problems associated with transporting radioactive material by passenger aircraft, the panel thought it best to obtain first hand information from persons and organizations engaged in the process and to witness the various separate activities that make up the entire process. Accordingly, the panel visited four different manufac-

*For a brief glossary of nuclear terms see page 23.

turing facilities where radiopharmaceutical products are manufactured and observed the methods by which these radioactive materials were packaged for shipment, including the monitoring to assure the packages meet Federal standards.

We visited cargo handling areas at the airport to talk with cargo handling personnel and observe the packages being loaded aboard planes. We talked with representatives from the Department of Transportation, including the Federal Aviation Authority and the Office of Hazardous Material and with representatives of the AEC from both the Regulatory and General Managers area. Also, we met with representatives of the Airline Pilots Association, and others who have been critical of the present situation as well as representatives from industry and the medical profession who use radioisotopes and who would be seriously hampered if the transportation of these products were severely curtailed.[1] In addition, we met with representatives of the Environmental Protection Agency (EPA) who are concerned with the general problems of population exposure to ionizing radiation.

One person, a biophysicist, was of the opinion that the shipment of all radioactive material, including medical radioisotopes, should be prohibited from airline passenger vehicles, unless the medical profession demonstrated proof to his satisfaction that radioisotopes were as essential as their increasing utilization would suggest. Another person interviewed, a biologist, suggested that the solution to the problem should be left to the public: that no technical or scientific body of experts has the right to determine what levels of manmade radiation is acceptable to the public. All others with whom we conferred, recognized the necessity to use scheduled passenger aircraft, at least for some short-lived radioisotopes, otherwise we would deprive some areas of the country of an effective diagnostic and therapeutic medical tool and the need to adopt enforceable rules and regulations. As might be expected, there were divergent viewpoints as to what, if any additional restrictions or limitations should be placed on the types and amounts of radioactive material permitted on passenger aircraft. In a few instances, knowledgeable persons were of the opinion no changes were necessary to present AEC and DOT regulations.

By and large, the consensus was that a more conservative approach should be adopted for the future and that greater restrictions than heretofore mandated by DOT and AEC were needed. These changes are considered necessary due to the increasing number of shipments and the mounting evidence that population exposure should be kept as low as practicable because of the increasing risks of genetic and somatic damage that relate to the accumulated exposure.

It should be noted that while the panel was in the process of considering this matter, and formalizing its recommendations, the AEC on July 30, 1974, formally submitted to the FAA recommendations for revising present regulations governing the transportation of radioactive material in passenger aircraft which are more restrictive than existing regulations. The panel has reviewed and considered those recommendations in arriving at the recommendations contained in this report.

[1] See Appendix A for a list of persons and organizations with whom the panel members conferred.

Although radioactive material is only one of numerous types of material that by DOT regulations are classified as hazardous, the shipments of which are specifically prescribed, the panel limited its review only to radioactive material and thus did not consider it within its purview to make recommendations concerning the other hazardous material.

However, since many of the individuals conferred with are familiar with the transportation of all types of hazardous material such as flammables, unstable chemicals, acids, and explosives, the panel did obtain some perspective as to the relative dangers between radioactive material and various other types of hazardous materials.

Without doubt, the potential danger to passengers and airline personnel from many other hazardous materials being carried on passenger aircraft today is far greater than from radioactive material shipments, and this should be borne in mind when reading this report and considering the recommendations contained herein.

Notwithstanding the apparent need for improvement in the regulation and control of other hazardous material—possibly a greater need than for radioactive material—the panel believes that the established national policy of exposing individuals to manmade radiation to a level as "low as practicable" should be adopted for each phase of the nuclear industry including the transportation field. The panel's recommendations as set forth in this report have been made in consonance with that policy which the panel believes to be the proper policy in that it is in the best interest of all concerned—the users and direct beneficiaries of nuclear material as well as the public at large.

II. DEVELOPMENT OF PRESENT REGULATIONS

The transportation of radioactive material by common carrier, including passenger aircraft, is regulated by DOT. Detailed regulations are issued by DOT as to packaging, labeling, and loading as well as to the maximum permissible level of radiation emitted external to the package. These regulations have been developed for the most part in cooperation with, and after review by, the AEC.

Present regulations limit the maximum external radiation levels of a package in routine commerce to 200 millirem per hour at the surface of the package and 10 millirem per hour 3 feet from the surface of packages. The level of radiation in millirem per hour at 3 feet from the surface of the package is called the package transport index (TI) and by current regulation may not exceed 10. By regulation a common carrier such as aircraft, truck, or rail car is not permitted to carry any single package with a TI greater than 10 nor any number of packages whose total TI will exceed 50. Minimum distances are supposed to be maintained between packages and airline passenger compartments to minimize radiation exposure to personnel and passengers.

The present DOT regulations governing the shipment of radioactive materials by aircraft originated in shipping regulations adopted on August 24, 1947, by the Interstate Commerce Commission based upon the technical specifications formulated by a seven-man National Research Council Committee of experts. At the time, the only official exposure limits to personnel were the March 17, 1934 occupational

levels of 100 millirem per day or 500 millirem per week which had been recommended by the Advisory Committee on X-Ray and Radium, the predecessor to the National Council on Radiation Protection and Measurement (NCRP). Since then, the NCRP, the International Commission on Radiological Protection (ICRP), the AEC, and the Federal Radiation Council (FRC) have lowered these levels by a factor of 5 for occupational workers, and by a factor of 50 for individual members of the public.

At the time the regulations were first being formulated in 1947, passenger airline transportation was not as common as it is today and the principal concern was not radiation exposure to passengers and crew but prevention of exposure to undeveloped photographic film to more than 14 millirem per hour at a distance of 30 feet in aircraft such as the DC-3 or Lockheed Lodestar.

Since the National Research Council first made its recommendations using the 1934 Advisory Committee on X-ray and Radium guide, the FRC and the AEC in addition to setting more conservative exposure levels for occupational workers and the public, have adopted the "as low as practicable" principle to conform with the basic concept that even the slightest amount of radiation exposure can be expected to do damage and hence a human being should not be exposed to any unnecessary radiation. The recent Report of the Advisory Committee on the Biological Effects of Ionizing Radiations (BEIR) of the National Research Council and the National Academy of Sciences also subscribes to and strongly supports the concept of keeping exposures as low as practicable. Although the AEC has proposed a guide of 5 millirem per year as being as low as practicable for limiting radiation to the general public for effluence from present civilian nuclear power plants, no such guide has been formulated for common carrier shipments of radioactive material.

III. BASIS OF PANEL'S RECOMMENDATION

It was obvious to the panel that with increasing numbers of radioactive material shipments, 200 millirem per hour at the package surface is too high and should be set at a lower limit to protect the cargo handlers who load and unload the shipments. Similarly the panel concluded that 10 TI—10 millirem per hour at 3 feet—is not as low as practicable and should be lowered for the better protection of passengers and crew. It was equally obvious that what may be as low as practicable for civilian nuclear power plants—the 5 millirem per year—is not practicable for shipping radioactive material and the same guide limit may not be appropriate in the transportation industry.

In attempting to formulate its recommendation, the panel was guided primarily by two key general principles contained in the November 1972 report of the Advisory Committee on the Biological Effects of Ionizing Radiations (BEIR report):

(*a*) No exposure to ionizing radiation should be permitted without expectation of a commensurate benefit.

(*b*) The public must be protected from radiation but not to the extent that the degree of protection provided results in the substitution of a worse hazard for the radiation avoided. Additionally, there should not be attempted the reduction of small risks even further at the cost of large sums of money that spent otherwise, would clearly produce greater benefit.

It was noted that in recent public hearings before a subcommittee of the Senate Commerce Committee, recommendations were made to ban the shipment of all radioactive material by passenger aircraft including short-lived radiopharmaceuticals.

One witness at those hearings, a biophysicist, voiced the belief that 75 percent of all medical isotope used was unnecessary. In contrast however, medical doctors, hospital physicists and other representatives of nuclear medicine, point to the growing use of radioisotopes in the early diagnosis of serious diseases with resulting savings of lives. According to the Society of Nuclear Medicine, approximately one patient out of every three admitted to hospitals today is directly benefitting from the use of medical isotopes, particularly the short-lived technetium-99m which has a half-life of 6 hours and which is a decay product of molybdenum-99. The latter has a half-life of 2.8 days. Hospitals that are not in the immediate area of a radiopharmaceutical supplier must generate their own technetium-99m from molybdenum-99 generators.

According to the AEC, a majority of all radioactive material transported by passenger aircraft is the radiopharmaceutical molybdenum-99 and the only practical way today of transporting this radioisotope to many areas of the country is by scheduled passenger aircraft. A somewhat similar situation pertains to such radionuclides as I-123 (13.2 hr.) and I-131 (8 days), components of nuclear medicines used for both therapeutic and diagnostic purposes.

To ban the shipment of all radioactive material by passenger aircraft would in effect deprive significant geographic areas of the United States of the use of these important nuclear medicines. In some cases it would force the medical profession to substitute longer-lived isotopes, as for example Iodine 131 for Iodine 123 resulting in significantly higher radiation exposures to the patient. Obviously there are significant benefits being derived from shipping short-lived isotopes by passenger aircraft particularly for those one-in-three hospital patients being serviced. The question is to what extent are these benefits commensurate with the undesirable effects of airline personnel and passengers being exposed to additional radiation from these shipments?

It should be noted that levels of radiation external to the individual packages of radioactive material in transit can be lowered as additional shielding is placed between the radiation source and the passenger and airline employees. Additional shielding could be used to lower and even eliminate, for all practical purposes, any measurable radiation external to the radioactive material package. However, the added shielding increases the weight and causes logistic problems associated with moving heavy packages and results in cost increases for the product which in the final analysis, in the case of nuclear medicines, will be borne by the patient. It becomes a matter of judgment then, at what point these added costs associated with the additional shielding are excessive and not commensurate with the benefits to be derived. As the BEIR report points out ". . . there should not be attempted

59 161

the reduction of small risks even further at the cost of large sums of money that spent otherwise would clearly produce greater benefit."

The main increase in cost however would occur from the need for the pharmaceutical supplier to make major changes in its production line to accommodate the heavier and larger shipping casks. That need along with the necessity to design and manufacture the new casks would entail increased costs and leadtime. The panel learned from its visits and discussions with the nuclear pharmaceutical industry, that because the industry is rapidly developing and quick changing, production equipment is being depreciated in short periods of 2 to 5 years. Even without new more stringent regulations, technical improvements and competition is causing the suppliers to limit the useful life of much of their production equipment to less than 5 years.

A recent study by Dr. Gordon Brownell, Professor, Department of Nuclear Engineering, MIT, calculates the varying dollar cost increases associated with lowering the permissible radiation emanating from packages of radioactive material by means of adding increasing amounts of shielding.[2] The Brownell report concluded that one could, by adding lead shielding, lower the TI (Millirems per hour at 3 feet) from the present maximum of 10 down to 1 but in the case of the large 500 millicurie molybdenum-99 generators[3] this would nearly double the cost of shipping. However, shipping costs represent a very small portion of the total cost of this product to the patients—approximately 100 patients or more are treated from one 500 millicurie generator. A doubling of the shipping cost would represent approximately 25 cents to 50 cents per patient whose bill is usually about $100 per treatment.

IV. DISCUSSION OF FINDINGS AND RECOMMENDATIONS

A. Permissible Radiation Level to Airline Passengers and Crew Due to Shipment of Radioactive Material in Cargo Spaces

Observation:

The present standards permit passengers of U.S. commercial aircraft to receive a maximum radiation dose rate of 10 millirem per hour at the passenger compartment floor level. This standard was arrived at over twenty years ago on the basis that it would be unlikely for any one individual of the overall U.S. population to make more than one or two flights per year. On this basis the 10 millirem per hour was established more on its possible effect on photographic film which might be on the aircraft than its possible effect on people.

The panel considers that the 10 millirem per hour allowable rate is too high and should be reduced. In establishing the new rate it must be assumed that a large and increasing segment of the population will be using commercial aircraft for public transportation and that a substantial number of them will be making numerous flights per year.

[2] Impact on the Cost of Shipping Radiopharmaceuticals of varying the Package External Radiation Levels—A report to the U.S. Atomic Energy Commission by Gordon L. Brownell, Ph. D., Professor, Dept. of Nuclear Engineering, MIT, and Director, Physics Research Laboratory, Massachusetts General Hospital, with the Assistance of John A. Correia, Ph. D., Research Fellow, Physics Research Laboratory, Massachusetts General Hospital—July 8, 1974.

[3] The 500 millicurie generator today is the largest sized unit being produced and shipped by radiopharmaceutical producers.

Consideration must also be given to airline stewards and stewardesses who are and will continue spending many hours per year in the passenger compartment of commercial aircraft. Tests have shown that pilots and crew members normally stationed in the flight control forward area are much less affected by radioactive material stowed in the baggage compartments and thus would be amply covered by any acceptable dose rate established for the passenger compartment.

The panel considered at length the determination of the proper radiation dose rate for passengers and flight crews. On one hand the panel agreed that 10 millirem per hour was too high a level to be acceptable. However, on the other hand, it was recognized that establishing a level of 0.1 millirem per hour would effectively preclude the shipment of radioactive material by passenger aircraft. The panel considers, for reasons discussed elsewhere in this report, that there is an overall benefit and requirement that radioactive material particularly for medical purposes be permitted to be shipped by passenger aircraft and that there is no reasonable alternative method of shipping.

Recommendation:

With regard to the permissible level of radiation the question of what is "as low as practicable" was reviewed taking into account the considerations previously discussed. Based on this review the panel considers that the applicable regulations should be revised to limit the radiation exposure to aircraft passengers and crew to 1 millirem per hour at the floor level. This limit was selected on the following basis:

1. It is in conformance with the concept of "as low as practicable." If it is assumed that the maximum amount of time a passenger or crew member is subject to such radiation would be for 20 hours per week for 50 weeks a year, then that person would receive one rem per year on the lower extremities. If translated to the more critical vital organs of the body this dosage would be in the order of 300 millirem per year—a figure generally accepted as being below that which might cause a detectable effect on the human body. It is also recognized that not all passenger aircraft flights carry radioactive material and even in those that do, very few of the passenger seats are directly above the area where radioactive material is stowed.

2. One millirem per hour is in conformance with the current Code of Federal Regulations (Title 10, Part 20, Atomic Energy) (10CFR20) which defines permissible levels of radiation in unrestricted areas as:

(*a*) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour, or

(*b*) Radiation levels which, if an individual were continuously present in the area, a dose in excess of 100 millirems in any seven consecutive days.

This regulation further defines a "Radiation Area" as any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems, or in any 5 consecutive days a dose in excess of 100 millirems.

692

3. It is considered feasible and reasonable to apply this more restrictive level insofar as the shipment of radioactive isotopes are concerned. The panel investigated the effect of reducing the Transport Index necessary to achieve this level and even though increased shielding would be required which in turn causes a weight increase and ultimately results in higher shipping costs, it is concluded that it can be done with a relatively small increase in cost to the ultimate consumer.

B. Recommended Modification in Regulations for the Shipment of Radioactive Material by Passenger-Carrying Aircraft To Reduce Exposures to Members of the Public and to Occupational Workers

Observation:

As previously indicated, the levels of radiation exposure permitted by present regulations for the shipment of radioactive materials by passenger carrying aircraft are based on very early radiation protection standards that have long since been outdated. They are insufficiently conservative in terms of present radiation protection standards. Furthermore, a vast amount of research data has accumulated over the past three decades which strongly suggests that, contrary to early concepts, there is no safe threshold radiation dose below which there is no consequential radiation damage; that the risk of radiation damage such as cancer induction or genetic malformations increases more or less linearly with the accumulated population dose. Today there are far more members of the public exposed to radiation from the shipment of radioactive material than when the present shipping regulations were established. This has come about because there has been an increase by orders of magnitude both in the number of packages of radioactive material shipped by passenger aircraft and in the number of persons traveling by passenger aircraft.

The present practices in the shipment of radioactive materials by passenger carrying aircraft permit passengers to receive a maximum exposure of about 10 millirem per hour. This is accomplished primarily by limiting the transport index of any package to no more than 10 (TI=10), by an upper limit of transport indices on any one passenger aircraft of no more than 50 (total TI=50) and by requiring that there be spacing of the packages in the baggage compartment in accordance with minimum separation distances listed in a table published in the shipping regulations. As would be expected, however, this method of control has been less than satisfactory because in the rush of loading packages on aircraft, too often little attention is given to the spacing and separation distances of packages of radioactive materials in the cargo holds. The panel believes that there is need both to reduce this dose rate of 10 millirem per hour to an airline passenger or member of the crew and to simplify the required loading procedure by which this can be accomplished (i.e., eliminate the use of the table for spacing of the packages).

The present regulations tend to limit occupational exposure to airline employees who load and unload the packages of radioactive materials on aircraft by setting an upper limit of 200 millirem per hour at the surface of the package. The panel believes there is need to reduce

occupational exposure received by the cargo handling personnel who load and unload these radionuclides. This can be accomplished by reducing the maximum permitted surface dose on a package of radioactive material. The exposure rate for stewards and stewardesses, on the average, is about the same as that received by some of the passengers. The pilots and the other flight crew in the pilot's quarters are sufficiently distant from the baggage compartments so that the cargo contributes essentially no radiation to these personnel.

Recommendations:

1. In order to reduce the maximum rate of radiation exposure received by passengers and crew of passenger carrying aircraft to approximately 1 millirem per hour the panel recommends the following:
   a. The transport index (TI) limit of a package be reduced from 10 to 1.
   b. The transport indices permitted on a passenger carrying aircraft be reduced from 50. The panel considers a limit of approximately 10 be set, however it recommends that the DOT and AEC determine such level in order to meet the 1 millirem per hour limit to passengers.
   c. The radioactive packages of Category III * should be placed on the floor of a baggage compartment of the aircraft (i.e., they should not be stacked).
2. In order to reduce the occupational radiation exposure received by airline employees who handle the packages of radioactive materials the panel recommends that the present maximum dose rate limits of 200 millirem per hour at the surface of packages of Category III be reduced by 25% to 50%. The panel believes a maximum level between a limit 50 and 100 millirem per hour should be established, and recommends that the DOT and AEC determine the lowest practicable limit within those limits.

TABLE 1.—RADIOACTIVE MATERIAL CATEGORIES—DOSE RATE LIMITS

[In MR/hr]

Category	Label	At any point on accessible surface of package	At 3 ft from external surface of package (transport index)
I	Radioactive—White I	0.5	0
II	Radioactive—Yellow II	10.0	0.5
III	Radioactive—Yellow III [1]	200.0	10.0

[1] Requires vehicle placarding. (This label mandatory for any fissile class III (173.389A) or large quantity package (173.389B), regardless of dose rate levels.)

C. Reducing the Risks of Radiation Exposure and of Environmental Contamination

Observations:

Under present DOT and AEC regulations radioactive material may be transported by common carrier, including passenger aircraft, if the shipments conform to specific limitations as to type, and quantity of material, and to specifically designed packages.

*See Table 1.

The types of packaging are specified in the DOT and AEC regulations according to the types and quantities of radioactive materials being shipped and the degree of containment the packaging is designed to provide under normal and accident conditions in transport.

Radioactive materials are divided into two broad classes: (1) "Special form" which is a massive, solid material, or material confined in a high integrity capsule of inert material, and (2) "Normal form" which applies to all radioactive materials which are not "special form." Normal form radioactive materials are classified into seven groups of radionuclides based primarily on radiotoxicity of the radionuclides. Package limits for the seven transport groups and "special form" are shown in Table 2.

Small quantities of radioactive materials, certain concentrations, small quantities of radioactive materials in manufactured goods, and low specific activity materials are exempt from specification packaging, marking and labeling.

TABLE 2.—TRANSPORTATION OF RADIOACTIVE MATERIALS—QUANTITY LIMITS AS RELATED TO PACKAGE REQUIREMENTS

Transport group: Examples	Exempt quantity (curies)	Type A package (curies)	Type B[1] package (curies)
I: Pu^{239}, Cf^{249}	10^{-6}	10^{-3}	20
II: Sr^{90}, Pb^{210}	10^{-6}	5×10^{-3}	20
III: Cs^{137}, Ir^{192}	10^{-5}	3	200
IV: Co^{60}, Cs^{134}	10^{-5}	20	200
V: Noble gases	10^{-6}	20	5,000
VI: Noble gases, uncompressed	10^{-9}	1,000	50,000
VII: Tritium as a gas or in luminous paint	25	1,000	50,000
Spec. form: Co^{60} for radiography, Pu Be	10^{-5}	20	5,000

[1] A large quantity is defined as any quantity in excess of a type B quantity.

Type A quantities of radioactive materials must be shipped in packages, identified as Type A packaging, designed to prevent loss or dispersal of the radioactive contents and retain shielding efficiency and effectiveness of other safety features under normal conditions of transport.

Quantities exceeding Type A quantities must be shipped in Type B packaging. Type B packaging must be designed to withstand normal transport conditions without loss of contents or shielding efficiency and to suffer no more than a specified loss of contents or shielding efficiency if subjected to a specified sequence of accident damage test conditions. Large quantities, exceeding Type B quantities, are not permitted to be shipped aboard passenger aircraft.

The panel notes that the risks of radiation exposure and its effects and of environmental contamination to passengers and crew increase (1) with the quantities (curies) of radionuclides shipped on passenger carrying aircraft as specified in the shipping regulations for the various Transport Groups and (2) as the radioactive half life of the radionuclide increases from a few days or weeks to months or years.

Recommendation:

Because of the desirability of reducing all radiation exposure to the lowest practicable level and in consideration of the expanding number of air shipments of radioactive packages, the panel recommends that the shipping regulations be modified so that (1) the quantities (curies) of radionuclides of Transport Groups I through IV and including Special Forms be reduced by a factor of at least ten below the present limits for Type A Packages and Type B Packages, and (2) the shipment of quantities in excess of Exempt Quantities by passenger carrying aircraft be prohibited if the radioactive half life of the radionuclide is between 30 days and 10^8 years.

394

The exclusion of shipments of large quantities of radioactive materials and especially those of longer half lives from shipment by passenger carrying aircraft would greatly reduce the risk of exposure to the more dangerous radionuclides such as Sr^{90}, Cs^{137}, Ra^{226}, Pu^{239} and Pu^{240}, Am^{241} and Am^{243}, etc. Also, it would prohibit the shipment of neutron sources such as Ra Be, Pu-Be, Cf^{249}, Cf^{250}, Cf^{252}, or Cf^{254}, where radiation risks are greater than those from gamma emitting radionuclides and the problems of shielding and radiation monitoring can be somewhat difficult.

In the case of leakage of the radionuclide from the shipping container, the risk of seriously contaminating the aircraft and baggage and of releasing significant quantities of airborne radioactive dust or fumes to the passenger section of the aircraft with consequential internal exposure of the passengers and crew would be reduced by an order of magnitude by recommendation (1) above and by many orders of magnitude by recommendation (2). (The upper limit of half-life of 10^8 years is specified in order not to needlessly restrict the shipment of natural thorium and of natural uranium and, of course, of stable isotopes whose half lives approach infinity.)

D. Monitoring Radioactive Shipments

Observation:

Under current AEC and DOT regulations, there is no requirement for radioactive material to be monitored by instrumentation to assure the package is complying with radiation standards, from the time the package leaves the facility in which the radioisotope was produced and packaged until it arrives in the hands of the addressee, the licensed user. In the interim period, it may have moved on a number of trucks and airplanes and have been loaded and unloaded by cargo handlers numerous times. It undoubtedly would have been stored for varying periods of time in interim cargo storage facilities as it passed from one location to another. If, the radioactive material has not been properly packaged, or if, for any reason, it began to leak, there would be no way of knowing this without some visible sign of the material coming from the package. Although the design of most packages used to transport radioactive material goes through a review process by AEC and DOT, and sufficient absorbent to prevent leakage is required, there have been occasions when material did leak, the source was not properly shielded or was transported in a position outside the shield, with resultant violations of radiation protection standards.

Concern for this problem, recently caused one airline—Delta—and one local agency—Minneapolis-St. Paul Metropolitan Airports Commission—each to establish its own personal monitoring system for radioactive materials in transit. Delta Airline, as a result of two serious violations in the last three years in which material was not properly

packaged and as a consequence of a continuing series of minor incidents, is training cargo handlers to use radiation monitoring equipment to verify that all packages identified as carrying radioactive material meet Federal regulations at the time of acceptance by the airline. This involves an extensive training program to qualify Delta personnel in the use and care of the sensitive instruments needed to accomplish this task. It raises a question as to the cost and duplication of effort if all other airlines subsequently follow or are made to follow the same practice. The more serious question is whether or not adequate training can be provided and maintained for all the radiation monitors that will be required if all airlines adopt this monitoring procedure now being implemented by Delta.

On April 25, 1974, the FAA published for comment in the Federal Register new regulations, which would among other things, require airline companies to survey, by instrumentation, all radioactive material at the time it is received from the shipper to assure the radioactive measurements are not greater than what the shipper's documents claim and are within the DOT standards. The new regulations would also require the airlines to survey passenger and cargo space using radioactive detection instruments to assure compliance with Federal radiation standards. The panel has reviewed and taken into account this proposed new regulation in the recommendations contained in this report.

Recently, the Minneapolis-St. Paul Metropolitan Airports Commission (MAC), a local agency, assumed the responsibility for the monitoring of the radioactive material coming through airports with in its jurisdiction, whether incoming or outgoing. In practice, the MAC is requiring the carrier to do the actual monitoring. One central monitoring station presumably could service all airlines within the Minneapolis-St. Paul International Airport. This would seem preferable to having each airline maintaining redundant capability at each airport. However, having local agencies assume the responsibility would not appear to be the most desirable approach unless it is done in conformity with national or international rules and regulations.

While the panel considers the action taken by Delta and MAC to be prompt and timely, the panel has concern that if each local government or airline were to set up a monitoring system, the multiplicity of rules and regulations and standards, which might eventually develop in different sections of the United States, would cause confusion and unnecessarily hinder the interstate transportation of radioactive material. What is needed is an effective and standardized Federal program of enforceable regulations.

Recommendations:

To prevent the multiplicity of State and local regulations and the potential for varying standards as well as possible conflicting regulations, the Federal Government should assume the overall responsibility for establishing and enforcing the regulations incident to the transport of radioactive material on a preemptive basis. No local, State, or independent agency should be permitted to establish regulations which are not in conformance with these Federal regulations. A Federal agency (some branch of the DOT such as FAA, for example, or the AEC) should be given the specific responsibility to monitor radioactive packages and certify them prior to being delivered to the carrier.

This function by the Federal Government would be similar to that function performed by the Food and Drug Administration in certifying Federal standards on meat and other food products requiring a Federal inspection. The panel recognizes that implementation of this recommendation will entail careful study and could require the addition of a large number of Federal employees. However, the panel also recognizes that there are a limited number of facilities that produce and ship radioactive isotopes. There is also a rather limited number of airports that receive these packages of radioactive material for shipment.

Initially, this program of Federal monitoring can be implemented by identifying the major airports through which the majority of radioactive material pass from the shipper to the air carrier. Based upon experience obtained and the continued growth of radioactive material shipments the Federal monitoring service could be expanded and eventually encompass ground transportation as well to the extent that no package carrying radioactive material other than exempted quantities, will be transported by common carrier without a Federal certification that it has been inspected and meets applicable standards for the health and safety of the public.

In addition to inspecting and certifying the individual packages, the Federal monitors should, by spot inspections, verify that the packages are being loaded aboard individual aircraft in accordance with prescribed rules and regulations to assure minimum radiation exposure to passengers and crew. All airport cargo ground storage space should have installed some gross (high level) instrumentation that would alert cargo handling personnel if radioactive material not properly identified is in the area.

As the standards for transporting radioactive material become more restrictive, it is important that some means be developed to detect attempts to circumvent the regulations by disguising the package or not properly identifying them as containing radioactive material. Surveillance of cargo storage and cargo loading areas with detecting instruments should also be the responsibility of the Federal monitoring agent, at the airport. The administration and operating cost of the monitoring service could be paid for by the individual shippers and the transportation industry, either through a fee based upon the number of packages certified for transportation and/or the licensing fee of the common carrier or shipper.

E. Transportation of Plutonium by Aircraft

Observation:

Under present AEC regulations, plutonium in quantities greater than 20 grams may not be shipped on passenger aircraft. This is a special limitation placed upon plutonium because the AEC properly is concerned that it not be diverted for illegal purposes. When a wave of airline "highjacking" occurred in the early 1970's, the AEC became concerned that one of the highjacked planes might have plutonium aboard and the highjackers knowingly or unknowingly transport this material out of the country.

Plutonium, in addition to being used in nuclear explosives, can be dangerous to the public health in that it is an alpha emitting radionuclide of long radioactive half life and if inhaled even in small amounts—micrograms—can do serious harm. Therefore, in addition to safeguarding plutonium from possible diversion, it is important that it be safely controlled so as not to constitute a risk to the health and safety of the public. All the other actinide radionuclides present risks similar to those of Pu^{239} when taken into the body, so precautionary measures applicable to Pu^{239} should be applied also to Pu^{238} and Pu^{240}, Am^{241} and Am^{243}, Cf^{252}, etc.

Light water slightly enriched uranium reactors in operation in the United States today produce plutonium as a byproduct. When the fuel element is reprocessed, the plutonium is separated from the uranium fuel. Relatively little plutonium has been separated from civilian nuclear reactor fuel elements in the United States to date, so the problem of transporting plutonium currently is not as pressing as it is destined to become in the future. As more nuclear power plants come into operation—by 1980 AEC estimates over 100 larger plants will be in operation in the United States—reprocessing plutonium will be moving from reprocessing plants to fabrication facilities and elsewhere in the nuclear industry. The strict control of this material particularly in transit will be a major problem that requires careful attention and will be addressed in the panel's next report. In the meantime, however, it is essential that even the relatively small amounts of plutonium and other actinide radionuclides in the civilian market not be permitted to constitute an unreasonable health and safety threat to the public.

Recommendation:

In addition to the reevaluation of maximum amounts permitted by regulation for A and B type packages, and the reevaluation of the levels of exempt amounts as recommended elsewhere in this report, the panel recommends that the AEC and DOT prohibit the shipment by air—air cargo as well as passenger aircraft—of other than exempt quantities of plutonium and other Transport Group I material unless a determination is made that the air shipment is necessary for the security of the Nation. The danger of an aircraft accident and resulting risk of contamination from plutonium, other actinides and other Category I material is sufficiently grave as to warrant their total restriction to ground and water transportation.

The panel recognizes that such a prohibition will cause an increase in the time these materials will be in transit and that ground and water way shipments of hazardous materials constitute separate risks but is of the opinion these risks are not as grave as those incurred by air tranport. In a future report, the panel will be prepared to recommend improvements in the control and administration of ground shipments for radioactive materials including plutonium and other Transport Group I material from both a safeguards as well as health and safety viewpoint.

596

F. Radioactive Material Packaging Design Review and Approval

Observation:

In accordance with their memorandum of understanding and their respective regulations, the AEC reviews and issues approvals for the designs of packages used in shipping significant amounts of radioactive material including fissile materials which are authorized by DOT regulations for use by shippers. However, certain Type B containers and fissile material "Specification Containers" are authorized for shippers use even though they have not been reviewed and approved by the AEC, i.e., they have received what is referred to as a "grandfather exemption". These include certain containers authorized by special DOT permits issued prior to July, 1973. In addition, prior to 1969 when DOT published the standards for the Type B containers many containers were in use under a so called Specification 55 which permitted the use of metal-encased lead or uranium metal shielded containers. Under a "grandfather clause" DOT regulations permitted continued use of those "Spec 55" containers used prior to 1969, if the material is in special form and not more than 300 Curies.

The 1971 Delta aircraft incident involved one of the special permit packages in existence prior to July, 1973 and thus was not of the type required to be approved by the AEC. Also the container involved in the July 1974 Delta aircraft incident in which the iridium source was not properly contained was a DOT Spec 55 container, Type C10, not reviewed and approved by the AEC.

Recommendation:

The panel recommends that all special permits and "Spec 55" containers that otherwise would be subject to AEC review and approval prior to use should be canceled and the use of these containers for transporting radioactive material in interstate commerce should be prohibited until such time as the AEC has reviewed and approved their use.

VI. SUMMARY OF MAJOR CONCLUSIONS AND RECOMMENDATIONS

1. *The maximum permissible level of radiation exposure for persons on passenger aircraft due to shipment of radioactive material stored aboard the aircraft should be one millirem per hour as measured anywhere within the passenger and crew compartments.*

2. Present maximum levels of radiation permitted for radioactive material in transit aboard passenger aircraft should be lowered. The maximum permissible Transport Index of 10 (10 millirem per hour at 3 feet) should be lowered to a Transport Index of one (1 millirem per hour at 3 feet) and the maximum permissible level of 200 millirem per hour at the package surface should be lowered by a factor of ¼ to ½ (50 to 100 millirem per hour). Total maximum permissible quantities of curies of radionuclides per package should be lowered by a factor of at least 10 below present limits.

3. Shipment by passenger carrying aircraft of radioactive material in excess of exempt quantities should be prohibited if radioactive half life of the radionuclide is between 30 days and 10^8 years. This would not apply to radioactive devices implanted in the human bodies of passengers, e.g., pacemakers.

4. The shipment by passenger and non-passenger aircraft of plutonium and other Transport Group I category material in excess of exempt quantities should be prohibited unless the air shipment is required for national security reasons.

5. All approvals or permits issued by DOT for shipping containers for radioactive material based upon "grandfather clauses" should be revoked pending review and approval by AEC.

6. The use of radium, accelerator products and certain other naturally occurring radioisotopes presently not being regulated by the AEC should be brought under AEC regulation.

7. Packages containing radioactive material for air shipment should be monitored subsequent to leaving the supplier and prior to being loaded aboard the aircraft to assure compliance with applicable Federal regulations. This responsibility should be assigned to a single Federal regulatory agency responsible for enforcement of the regulations and not upon the airline carrying the cargo. The responsible Federal agency should also be responsible for periodic inspections to assure all regulations pertaining to air transportation of radioactive materials are being complied with.

The panel believes that with the exception of No. 6 above, which will require congressional action—specifically amendment to the Atomic Energy Act of 1954—all of the above recommendations can be adopted through Administrative action as they would be within existing statutory authority. Recommendation No. 7 above, if adopted, would increase significantly the present level of monitoring and enforcing Federal regulations. It might be more appropriate if this were accomplished by legislative mandate rather than being left to Administrative determination.

VII. ADDITIONAL RECOMMENDATIONS

1. It is apparent that in some degree the heavy dependence on passenger aircraft for transporting radioisotopes for medical purposes is because of convenience rather than necessity. Even recognizing the need to transport short half-life isotopes without delay, the use of land transportation could be more effectively used particularly for relatively short haul distances. The panel recommends that shippers of radioactive isotopes make a greater effort to develop and use land transportation wherever possible.

2. Recognizing the need to continue the competitive nature of the production and sale of radiopharmaceuticals, the panel recommends that users such as hospitals and doctors, attempt to purchase their short half-life radioisotopes from the closest supplier. This would not only reduce the number of air shipments but would significantly reduce the amount in curies of radioactive shipments by passenger aircraft.

3. Information provided to the panel indicates that the current practice in the medical profession is to have the Mo^{99} generators available at the hospital beginning on each Monday morning for use through the following Friday. This provides the most effective use in the hospital because of the short half-life feature of the isotope. Because of this, most radiopharmaceutical producers manufacture their product on Thursday or Friday and ship late Friday or Saturday. In order to insure that the ordered quantity (in curies) is available on Monday morning, a sufficient excess quantity to compensate for the amount lost by radioactive decay must be produced and shipped. In some cases the hospital will request sufficient quantities of the radioisotope in order to have a full supply available on Friday rather than Monday. The panel was told, for example, that in order to insure that the hospital has 500 millicuries of Mo^{99} at the hospital on Friday morning, the producer ships approximately 2,500 millicuries on the previous Friday or Saturday. The panel considers that by properly revised scheduling the quantities (in cuies) of radioisotopes shipped by passenger aircraft can be reduced. The panel saw little evidence of any effort on the part of the producers or users to do this.

4. The panel noted that in the packaging of liquid radioisotopes for shipment there is no requirement to place the bottle in a sealed plastic bag before insertion into the shielded container. This is an inexpensive step generally followed throughout the nuclear industry today and should be incorporated into the packaging requirements.

5. As an added precaution against gross mishaps or illegal shipments of radioactive material, the panel recommends the installation of high-level radiation monitors in cargo handling spaces and perhaps other areas of major airports. Such a device would have immediately detected the recent incident involving the air shipment of an unshielded industrial isotope.

6. The panel considers that the airlines should voluntarily assume a more active role in monitoring their operation with regard to shipping radioactive material. There appears to be a general feeling among the airline companies that the responsibility for safe shipment of radioactive material rests with the shipper and the Federal Government. Although the panel is not recommending the AEC licensing of air carriers, it does feel that the airlines can and should take a more active role. It would not be unreasonable to expect each airline to hire one or two persons trained and qualified in health physics to provide airline management with some surveillance capability. Such capability would provide the airline with some assurance that required procedures are being followed within their own operations.

7. Until and unless carriers become licensed to handle radioactive material, shippers must be held responsible for safe shipment of such material until it reaches its destination. The panel is of the opinion that some shippers of radioisotopes to a large degree consider their responsibility complete once they have packaged their product in accordance with the requirements and have turned it over to the carrier, even though he is not trained in the proper control of radio-

594

active material. Although unsubstantiated, it was reported to the panel that some shippers are aware and condone illegal practices followed by some land carriers once their shipments have been turned over to that carrier. However, the panel did observe one manufacturer who aggressively supervised all phases of the transportation cycle until the product was in the hands of the licensed user. The panel was unable to find any evidence where the Federal Government (AEC) inspected or regulated the operation of land carriers who transport radioisotopes from the shipper to the airports for air shipment. The panel recommends that this situation be corrected; that the enforcement of the shipper's license to handle radioactive material be extended to cover all truck or auto movement of the radioactive material until it is received by another licensed activity.

8. The requirement exists that pilots be advised in writing of the presence of radioactive shipments on their flights. The panel notes that this requirement is not consistently being followed in that cargo manifests do not always show the existence of such shipments. The panel recommends that airlines review their current procedures to ensure compliance with this requirement.

9. The panel recommends that airline passengers, if they ask, be told whether or not radioactive material is being carried on their particular flight. If, because of this, they chose not to fly on that flight, the choice is theirs. The panel does not consider that the airlines should, under such circumstances, be required to provide the passenger with so-called "bumping rights."

10. Although no requirement exists, the panel considers it prudent that a film badge or TLD be installed on selected aircraft, passenger and cargo. This monitor could be installed in an inconspicuous location in the passenger area and be read each thirty days. A monitor should also be placed in an appropriate location in the cargo handling spaces of major airports where radioactive material is stored. The individual airlines should conduct this surveillance and report their results to the FAA.

598

APPENDIX A

List of individuals with whom the Panel conferred in connection with the problems discussed in this report.

Dr. Calvin Brantly, *Chairman*, AIF Isotope Committee.

Capt. William H. Briner, Duke University Medical Center (Society of Nuclear Medicine-Transportation Committee).

Dr. Jerry Bruno, E. R. Squibb & Sons, Inc.

Mr. William J. Burns, *Director of Hazardous Materials*, Department of Transportation.

Dr. Barry Commoner, *Director*, Center for Biology, of National Systems, Washington University.

Mr. John F. Derr, Products and Systems Development, Director, E. R. Squibb & Sons, Inc.

Mr. Sam Edlow, Edlow International Associates.

Dr. Meril Eisenbud, NYU Environmental Health Laboratory.

Mr. Joseph A. Ferrarese, *Chief*, Flight Operations Division, Flight Standards Service, Federal Aviation Administration.

Mr. Ken George, *Senior Research Scientist*, E. R. Squibb & Sons, Inc.

Mrs. Margaret Glos, *Executive Director*, Society of Nuclear Medicine.

Mr. Kenneth J. Green. *Manager*, Radiopharmaceutical Distribution, Mallinckrodt Nuclear Corp.

Mr. Al Grella, Office of Hazardous Materials, U.S. Department of Transportation.

Mr. Saul Harris, *Chief*, Radiation Bureau, Department of Health, New York City.

Mr. Dean B. Holzgaf, *Manager*, Nucleonics Business, E. R. Squibb & Sons, Inc.

Miss Pat Kennedy, Aviation Consumer Action Project.

Mr. Peter M. Kirby, *Director*, Federal Legislation, Air Transport Association of America.

Mr. Clifford J. Konnerth, *Chief*, Health Physics, E. R. Squibb & Sons, Inc.

Mr. Sam Langford, Aviation Safety, Federal Aviation Administration.

Gerald M. Mayo, Esq., Legal Division, Delta Air Lines, Inc.

Dr. Gerald McDonald, Good Samaritan Hospital in California.

Mr. James J. McGovern, *Superintendent*, Nuclear Operations, E. R. Squibb & Sons, Inc.

Mr. Robert B. Minogue, *Deputy Director*, Directorate of Regulatory Standards, Atomic Energy Commission.

Kathleen O'Neill, Esq., Attorney, Air Transport Association of America.

Mr. Harold T. Raven, *Transportation Manager*, E. R. Squibb & Sons, Inc.

Mr. Harry Richardson, *President*, NSI, Baton Rouge, La.

Mr. William Robb, Quality Assurance–Radiopharmaceuticals, Mallinckrodt Nuclear Corp.

Dr. William Rowe, Environmental Protection Administration.

Mr. Don Soldan, Radiation Safety, Mallinckrodt Nuclear Corp.

J. G. Speth, Esq., Natural Resources Defense Council, Inc.

Dr. Arthur Tamplin, National Resources Defense Council, Inc.

Dr. Robert Zimmerman, Consultant to Delta Airlines.

APPENDIX B

JOINT COMMITTEE ON ATOMIC ENERGY,
UNITED STATES CONGRESS,
Washington, D.C., May 30, 1974.

Mr. JOHN T. CONWAY,
Executive Assistant to the Chairman of the Board, Consolidated Edison Co. of New York, N.Y.

DEAR JOHN: We want to thank you and your colleagues for taking on the difficult task of looking into the problems of transporting nuclear material to assure that it is properly safeguarded and that adequate safety and security precautions are taken.

The Joint Committee looks forward to the results of your deliberations. We are particularly anxious to know if any changes in present activities are needed at the present time. Accordingly, it would be appreciated if you would concentrate your efforts on determining what, if anything, is now being done incorrectly. We would also suggest that you inform the committee of impending problems you foresee in the future as our nuclear activities increase in order that they may be given attention in the future.

In order for your work to be of greatest value to the committee, it would be appreciated if results of your deliberations were made available in about two or three months. We then could, if deemed necessary, take any legislative action that is required in the present congressional session. Also, since the handling and transportation of nuclear weapons is significantly different from the procedures for other types of nuclear material, it would appear appropriate that you exclude the handling and transportation of weapons from the scope of your study. However, you are authorized to review the transportation and handling of nuclear weapons to whatever extent you believe necessary or helpful in arriving at your recommendations.

Sincerely,

MELVIN PRICE, *Chairman*,
JOHN O. PASTORE, *Vice Chairman*.

599

GLOSSARY

Absorbed dose. When ionizing radiation passes through matter, some of its energy is imparted to the matter. The amount absorbed per unit mass of irradiated material is called the absorbed dose, and is measured in *rems* and *rads.*

Actinide series. The series of elements beginning with actinium, Element No. 89, and continuing through lawrencium, Element No. 103, which together occupy one position in the *Periodic Table.* The series includes uranium, Element No. 92, and all the man-made transuranic elements. The group is also referred to as the "Actinides".

Alpha particle. A positively charged particle emitted by certain radioactive materials. It is made up of two neutrons and two protons bound together, hence is identical with the nucleus of a helium atom. It is the least penetrating of the three common types of *radiation* (alpha, beta, gamma) emitted by radioactive material, being stopped by a sheet of paper. It is not dangerous to plants, animals or man unless the alpha-emitting substance has entered the body.

Beta particle. An elementary particle emitted from a nucleus during radioactive decay, with a single electrical charge and a mass equal to $\frac{1}{1837}$ that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron.

Curie. The basic unit to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any nuclide having 1 curie of radioactivity.

Gamma rays. High-energy short-wavelength electromagnetic radiation. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials, such as lead or depleted uranium. Gamma rays are essentially similar to X rays, but are usually more energetic, and are nuclear in origin.

Genetic effects of radiation. Radiation effects that can be transferred from parent to offspring. Any radiation-caused changes in the genetic material of sex cells.

Isotope. One of two or more atoms with the same atomic number (the same chemical element) but with different atomic weights. An equivalent statement is that the nuclei of isotopes have the same number of protons but different numbers of neutrons. Thus, $^{12}_{6}C$, $^{13}_{6}C$, and $^{14}_{6}C$ are isotopes of the element carbon, the subscripts denoting their common atomic numbers, the superscripts denoting the differing mass numbers, or approximate atomic weights. Isotopes usually have very nearly the same chemical properties, but somewhat different physical properties.

Isotopic enrichment. A process by which the relative abundances of the isotopes of a given element are altered, thus producing a form of the element which has been enriched in one particular isotope. Example: enriching natural uranium in the uranium-235 isotope.

Maximum loading. The maximum number of packages of radioactive material that can be transported in a cargo compartment of an aircraft, in terms of the total of the transport indexes on those packages.

Millicurie (*see* curie). $\frac{1}{1000}$ of a curie.

Millirem (*see* rem). $\frac{1}{1000}$ of a rem.

600

Neutron. An uncharged elementary particle with a mass slightly greater than that of the proton, and found in the nucleus of every atom heavier than hydrogen. A free neutron is unstable and decays with a half-life of about 13 minutes into an electron, proton, and neutrino.

Radiation. The propagation of energy through matter or space in the forms of waves and fast-moving particles.

Radioactive labels. Labels bearing the unique trefoil radiation warning symbols which are required to be placed on two opposite sides of each package of radioactive material. Each radioactive label shows the contents, the amount of radioactivity in curies, and on radioactive yellow-II and radioactive yellow-III labels, the number of transport indexes. Labels are divided into:

(1) radioactive white-I label—for each package not exceeding 0.5 millirem per hour at any point on the external surface of the package, not authorized for Fissile Class II packages;

(2) radioactive yellow-II label—for each package exceeding limits of radioactive white-I label, but not exceeding 10 millirems per hour at surface and not exceeding TI of 0.5; and

(3) radioactive yellow-III label—for each package exceeding limits of radioactive yellow-II label, each Fissile Class III package, each large quantity package, and each package being transported under a DOT permit.

—Half-life. Time required for a radionuclide to lose 50 percent of its activity by decay. Each radionuclide has a unique half-life.

Radionuclide. An unstable isotope of an element that decays or disintegrates spontaneously, emitting ionizing radiation.

Rem (Acronym for roentgen equivalent *man.*) The unit of dose of any ionizing radiation which produces the same biological effect as a unit of absorbed dose of ordinary X-rays.

Roentgen (Abbreviation r) A unit of exposure to ionizing radiation. It is that amount of gamma or X-rays required to produce ions carrying 1 electrostatic unit of electrical charge (either positive or negative) in 1 cubic centimeter of dry air under standard conditions.

Separation distances. The distance between the passenger side of the floor or partition of the passenger compartment and the nearest surface of a package of radioactive material stowed in the cargo compartment.

Somatic effects of radiation. Effects of radiation limited to the exposed individual, as distinguished from genetic effects.

Spacing-out. A configuration for loading packages of radioactive materials in the cargo compartment of an aircraft which allows an aircraft to carry several groups of packages simultaneously; the spacing-out configuration limits the number of packages in each group and specifies minimum separation distances and distances between groups of packages.

TLD. Thermoluminescent dosimeter.

Transmission factor. The fraction of radiation passing through the aircraft structures between the radiation source and the dose point of interest.

Transport index (TI). The number placed on the label of a package of radioactive material to designate the degree of control to be exercised by the carrier during transportation. The transport index is equal to the larger of the following:

the highest radiation dose rate, in millirem per hour at three feet from any accessible external surface of the package; or for fissile material packages, the number 50 divided by the number of similar packages which may be transported together under AEC rules.

○

601

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

8 MAY 1975

Mr. Lee V. Gossick
Executive Director for Operations
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Gossick:

The purpose of my letter is to express our concern regarding the shipment of plutonium and possibly other special nuclear materials by commercial aircraft. In recent weeks there has been much publicity concerning the safety of such shipments, especially with regard to the use of airports located in major urban centers such as New York City. Since an aircraft accident involving plutonium could potentially lead to serious environmental and public health effects, we believe that steps should be taken to assure protection of the public health and the environment in conducting these shipping activities.

We are familiar with the exemplary safety record for radioactive materials shipments, the general philosophy of providing protection in transit through the use of specifically designed shipping containers, and the widely accepted tests to which these containers are subjected prior to licensing. To our knowledge, however, there exists no specific assessment of the risk involved in transporting plutonium, or for that matter, other radioactive materials routinely in air commerce. Thus, we are unable to make judgments regarding the relative risks of this transportation. Probably the most immediate problem lies in estimating the potential consequences of an aircraft accident occurring in a major metropolitan area, such as the New York City area.

We believe that before the commercial air transportation of plutonium becomes widespread, it would be prudent from a public health standpoint for NRC to examine th risk involved in such transportation in detail. EPA is currently investigating the problem of plutonium contamination of the environment. This program is being coordinated with other agencies through an interagency liaison committee, on which the NRC is represented by Dr. Roger Mattson of the Office of Standards Development. We suggest that a risk assessment effort in this area could be coordinated through this committee.

Exhibit B

602

Further, there has been some inquiry to EPA pertaining to the need for an environmental impact statement for this problem area. We note from your letter of April 3, 1975, to the Joint Committee on Atomic Energy that an environmental impact statement will be prepared in connection with the planned rulemaking proceedings regarding this issue. Perhaps the interagency committee might also be of assistance in focusing on the scope of such a statement.

We would be most happy to discuss this issue with you at your convenience.

Sincerely yours,

W. D. Rowe, Ph.D.
Deputy Assistant Administrator
for Radiation Programs (AW-558)

cc: Dr. Mattson

Project Crested Ice

USAF Nuclear Safety

AFRP 122-1 JAN/FEB/MAR 1970, NO. 1 VOLUME 65 (PART 2) SPECIAL EDITION

DEPARTMENT OF THE AIR FORCE
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The Inspector General, USAF

MAJ GEN EDWARD M. NICHOLS, JR.
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For Inspection and Safety, USAF

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CONTENTS

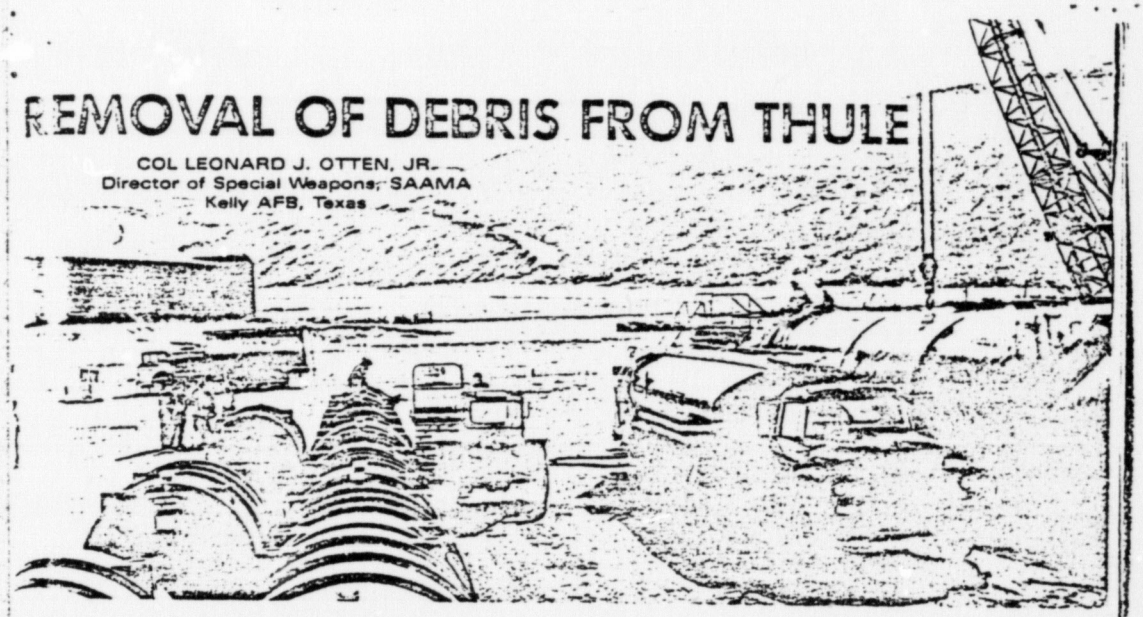
The Flight of HOBO 28 2
The Thule Affair 5
The Evaluation of Possible Hazards 8
The Commander's Point of View 12
Host Base Support 25
Crested Ice Public Affairs Program 32
Technical and Laboratory Support 36
Danish Group Scientific Investigations 42
Radiological Monitoring 45
Fidler on the Roof of the World 52
USAF Radiological Health Laboratory Support 54
Investigations and Evaluations of Contamination Levels 57
Ecological Background 64
Ecological Survey 70
Radio-Ecological Investigations 74
Danish Health Physicists' Activities 80
Ice Operations 82
Ice Investigations 84
Removal of Debris from Thule 87
North Star Bay Oceanography 91
EPILOGUE—From the Danish Point of View 96
EPILOGUE—From the American Point of View 97

Exhibit C

604

REMOVAL OF DEBRIS FROM THULE

COL LEONARD J. OTTEN, JR.
Director of Special Weapons, SAAMA
Kelly AFB, Texas



WITH the completion of on-site evaluation and recovery operations by the Strategic Air Command (SAC), effort was directed toward the problem of dealing with the contaminated waste. During recovery operations, 217 various sized containers of aircraft residue and sixty-seven 25,000-gallon tanks of contaminated snow and ice from the site were collected. In addition, there were four 25,000-gallon containers filled with such items as tires, clothing, tools, plywood, and parachutes.

Transportation requirements for a removal operation of this size created a problem of great magnitude. It was decided to turn the job over to the Air Force Logistics Command (AFLC). Within the command the task was assigned to the Directorate of Special Weapons located at the San Antonio Air Materiel Area (hereafter referred to as SAAMA), Kelly AFB, Texas. Lt Col Vernon E. Carkin, Chief of the Production Management and Technical Services Division, served as Project Officer.

To gather all necessary information, a meeting was held at SAC Headquarters on 8 April with personnel who had recently returned from Thule Air Base following recovery operations. The main questions concerned the amount of waste requiring disposal and its degree of contamination. These questions were directed to the civil engineers and health physicists.

The SAC Civil Engineers estimated that the 67 petroleum, oil and lubricant (POL) tanks were 85% full, with approximately 4,500 gallons of melted snow and ice in each tank. They recommended a filtration process be used to decontaminate the liquids. This would allow the effluent to be discharged into the bay and would eliminate the necessity of transporting the liquids to the United States for disposal. However, the health physicists did not fully agree with this concept due to the high degree of purification required to meet international drinking water standards.

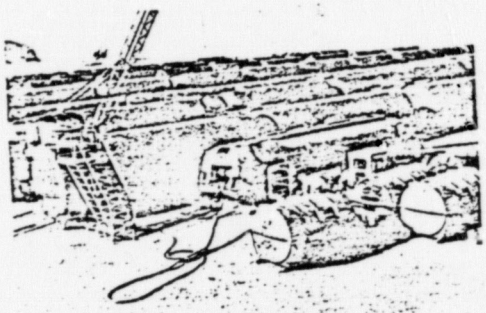
Returning to SAAMA, another meeting was called with personnel from the Atomic Energy Commission, Aerospace Defense Command, and AFLC, who had been at the site. Many ideas and suggestions concerning the handling, storage, and transportation of the radioactive materials resulted from the conference. To insure thorough evaluation and consideration of each suggested plan, a formal staff study was prepared. Many aspects including international opinion, feasibility, climatic and geographic conditions were considered in the study.

Three alternatives were proposed. A brief summary of the plans follows:

One plan was to ship all of the 25,000-gallon tanks and smaller containers, filled with contaminated waste, to the United States for disposal. However, the disadvantages of this plan were far greater than the advantages, with such problems as the requirement for extensive cradling supports from the tank farm to the ship, and also aboard ship. Another hazard was the tilted entry of partially filled tanks into the ship. These procedures could prove to be extremely dangerous.

The second plan provided for handling the radioactive waste by filtration and dilution. The frozen waste was to be melted in the POL tanks. The "clear" liquid between the scum and sludge layers would be pumped through a five-micron filter, followed by three one-micron filters placed parallel and leading to a holding tank. Again, the disadvantages proved too great. The

605



TANK FARM. Pump-transfer crews prepared to pump melted snow water from the large 25,000-gallon tank to small containers to facilitate shipping the residue to the U.S.

problem was that an adequate filtration system, with necessary operating procedures, had not yet been designed, fabricated, and service tested.

The third plan provided for transfer of radioactive waste into smaller transportable tanks for return to the United States for disposal. Radioactive residue in the POL tanks would be melted and the liquid pumped into smaller tanks made from modified engine containers of 1,800-gallon capacity which were excess to the Air Force needs. The tanks would then be transported from the shoreline storage area to the ship docking area for loading aboard cargo ships. The tanks would be shipped to the United States and transferred to railroad cars for shipment to Atomic Energy Commission designated disposal areas. Empty POL tanks, which originally held the material, would be sent to designated disposal areas as well.

This alternate was approved by the Air Force Logistics Command, Aerospace Defense Command, the USAF Directorate of Nuclear Safety, HQ USAF, Department of Defense, Department of Transportation, Department of State, and the Atomic Energy Commission. After this process, the plan was coordinated with and approved by the Danish Government.

An adequate number of the smaller, modified tanks were available at SAAMA, as well as F-6 aviation gas refueling units which were used as on-site portable pumping equipment. Prior to approval for use, the modified cans were subjected to a severe testing program for leaks, stability, and durability.

To determine the conditions at the site, what equipment was available, and what problems would be encountered during the actual removal and disposal operation, a team of highly specialized personnel visited Thule Air Base.

Upon the team's return from Thule, the SAAMA Military Personnel Office selected the personnel who would make up the on-site task group.

Decontamination personnel unloaded forklift inside designated bunker.

On the morning of 25 June, the hand-picked on-site team assembled at the Directorate of Special Weapons conference room to learn of their assignment. The team consisted of 24 personnel—one officer, 18 airmen, two civilians from SAAMA, two airmen from the Tactical Air Command, and one from SAC.

Faint murmurs ran through the group. What is this all about? What is Project Crested Ice? How long will this thing last? And, of course, why me?

These and all other questions were answered during a comprehensive briefing concerning the mission, constraints and time schedules, international interests and relationships. Individual crew assignments were made in the major areas of effort: melting, pump transfer, radiological monitoring, packaging and transportation, and finally, administrative and control functions.

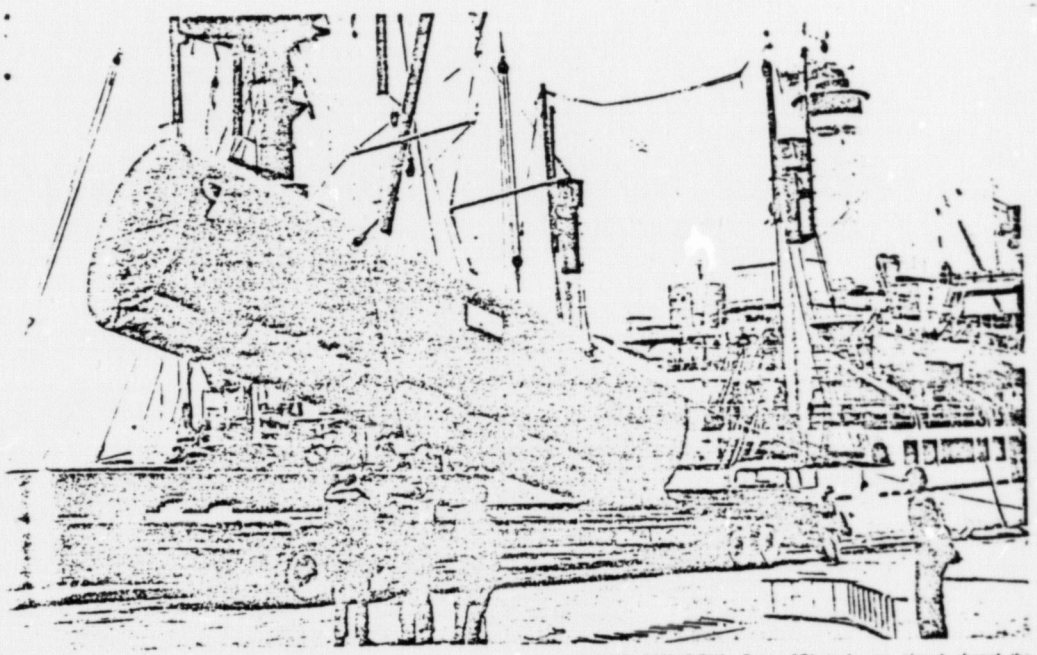
Training the task group began on the 26th of June at Kelly Air Force Base. The training was unusual; the circumstances were unusual. Some learned to heat ice filled tanks rather than aircraft engines, others to pump-transfer radioactively contaminated liquids without spillage instead of pumping aviation fuels, while still others learned to palletize and label drums of radioactively contaminated aircraft debris rather than oil drums.

The personnel who were given secondary or augmenting assignments were cross-trained. Those not currently qualified to operate related equipment received intensive training and were licensed by Kelly authorities. On 11 July, the team left Kelly Air Force Base on a C-118 which became affectionately known as "Thule Commuter's Special."

Upon arrival at Thule the following day, the group was briefed by the SAAMA Advance Liaison Officer. The briefing included a tour of the local area.

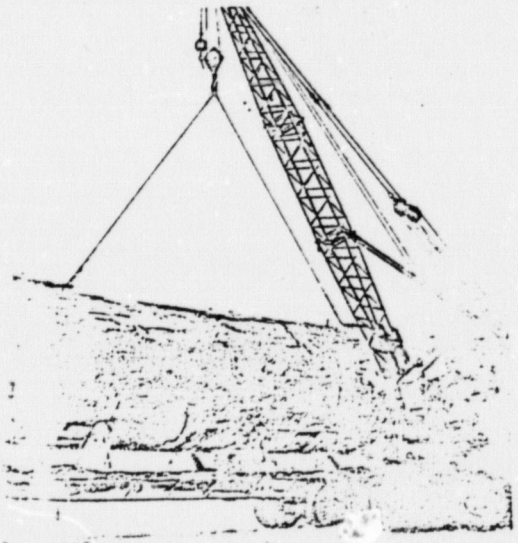
On 16 July the USNS TOWLE, of the Military Sea Transport Service, docked at Thule's DeLong Pier and immediately began unloading the Crested Ice equip-

606



LOADING OPERATIONS. Empty POL tanks are placed aboard the USNS TOWLE for shipment to Charleston, South Carolina.

Fuel tank being lifted onto flatbed by crane.



ment, including 232 modified engine containers and two F-6 refueling units.

To protect against spillage, additional equipment was manufactured at Thule Air Base. Sheet metal pans were made to place under the F-6 units and collars were fabricated to encircle the R-4360 filler caps and POL tanks to soak up contaminated liquid from suction or discharge nozzles.

Other innovations were made such as the adaption of a POL system filter unit to fit around the suction nozzle to screen out debris from the POL tanks.

All preparatory efforts of the pump-transfer operations were completed by 22 July.

The igloo area operations began 17 July with the manufacture of barrier bags to completely contain and seal the drums and cans of residue for shipment.

During the operation, it was discovered that one of the modified cans and one POL tank had leakage due to punctures. However, it was determined that the liquid was not "hot" and the containers were repaired with an epoxy compound.

Additional safety briefings were held by the On-Site Health Physicist, Capt William Moyer. He reviewed the hazards and demonstrated the use of available protective clothing and gear.

Final pump-transfer operations began 22 July, with two crews, each with a radiological monitor, operating 10 hours a day. Competition immediately sprang up between the crews to see which could pump the greater amount each day.

607

Thanks in part to the prevalence of good weather, 49 of the 67 POL tanks of contaminated liquid waste were emptied and two hundred and thirty-one R-4360 containers filled by [illegible]. One-hundred gallons were left in each POL tank as a dampener to lessen the danger of sparking effects of debris. The 232d container was sent to the Danish Construction Corporation, a Thule Air Base contractor, to serve as a model for modification and test of the eight R-4360 cans arriving on the USNS TOWLE's second trip to Thule.

Since the USNS TOWLE was not due to return to Thule until 18 August, the members of the task group returned to their home stations. The Thule operations were secured and in the custody of two task group members. Their tasks included housekeeping, maintaining daily [illegible] over filled containers, and to maintain [illegible] up.

[illegible] assembled and returned to Thule Air Base on 19 August. Upon arrival, additional modification of the previously filled cans was necessary.

A .0625-inch hole was drilled in the filler caps with a rubber surge chamber inserted to eliminate any possible air/gas pressure build-up inside containers as they were transported from a 30-40 degree environment to the possible 90-100 degree temperature of the Southern United States.

When the USNS TOWLE arrived on 21 August, its cargo of an additional 80 unmodified R-4360 cans was taken to Hangar 1 for modification. The last container was completed on 31 August.

The loading of the USNS TOWLE began with eight POL tanks, 50 pallets of 192 drums and 268 filled R-4360 cans during the period 26 August to 1 September.

Departing Thule's DeLong Pier on 2 September, the USNS TOWLE headed for the Army Pier at Charleston, South Carolina, with a due date of 11 September.

When the USNS TOWLE arrived at the South Carolina pier, railroad cars were waiting to take the contaminated debris to its final resting place. Sixty-six cars were needed to carry the load which was moved at a speed of not more than 30 miles per hour.

The second ship, the USNS MARINE FIDDLER, arrived at Thule on 3 September and began loading

FILL 'ER UP. Airmen at Thule fill engine container with melted snow water pumped from the larger POL tank.

FINAL CHECK. A radiological monitor checks for contamination of alpha particles on the clothing of a pump transfer operator by using PAC-1S scintillator detector.

Crested Ice retrograde cargo. It departed on 17 September with forty-seven R-4360 cans and five 25,000-gallon POL tanks, 67 empty 25,000-gallon POL tanks and eleven 3,000- to 10,000-gallon POL tanks of residue and the two F-6 refueling units. The MARINE FIDDLER arrived in Charleston on 28 September with its cargo. It was necessary to use 81 railcars to transport the containers. To keep the material from sloshing to any great degree and because of the close clearances, the train moved no faster than 20 miles per hour to its destination.

With Thule Air Base secured, the task group departed on 6 September, after assuring that the former tank farm area was left clear and monitored to a zero contamination level. The AFLC/SAAMA project close-out responsibilities were completed.

SUMMARY

We would be remiss if we did not acknowledge the contributions made by the Danish Nationals assigned to Thule Air Base. They were, without exception, professionals in their jobs and their cooperative and constructive attitudes were outstanding. The SAAMA team will long remember these fine people, both for their proficiency and for the warm personal relationships that developed.

Our only regret is that we could not have met with the Danes under happier circumstances.

608

TECHNICAL AND LABORATORY SUPPORT

DR WRIGHT H. LANGHAM
Los Alamos Scientific Laboratory
University of California
Los Alamos, New Mexico

A contamination incident such as the one described in other articles in this magazine invariably creates a real or anticipated need for specific technical information not readily available or easily obtained under field conditions. The type of supplemental information required is usually determined by the specific needs of the field commander and various special committees and policy-setting groups as an adjunct to their making decisions as to the extent of contamination, the magnitude and nature of the potential hazards to operational personnel and the inhabitants of the region (whether direct or through ecological modes), and the extent of decontamination that is acceptable and technically feasible.

Within 5 days after the incident an American technical advisory group was assembling at Thule, and discussions were initiated with a similar group of Danish and Greenland scientists. In the next few weeks various agencies (Atomic Energy Commission [AEC], Department of Defense [DOD], etc.) assembled expert committees to advise them. In addition, joint U.S.-Danish policy-setting groups met in Copenhagen and Washington to consider the technical aspects of the incident. The final decisions as to clean-up levels, methods of disposal and many other issues were made by these high-level groups and committees. Since these authoritative committees and groups needed all the information possible within the time frame of the negotiations, the demands placed upon the field operations became one of the field commander's biggest problems. Often these demands could not be met without additional technical and laboratory support beyond that available at the scene. To comply with these demands, data and samples were sent to the Los Alamos Scientific Laboratory and other laboratories in the U.S. for analysis and interpretation. This article summarizes the early work done at the Los Alamos Scientific Laboratory and elsewhere in an effort to provide some of the information requested.

PARTITIONING OF THE CONTAMINATION

In an incident of this type the most important information to have as soon as possible is the absolute quantities of material partitioned among the various vectors, modes or regions of dispersal, and deposition. At Thule the important considerations in this regard were:

- The amount of contamination carried aloft in the cloud from the detonation of the high-explosive and fire and dispersed over the general area by the prevailing meteorological conditions.
- The amount deposited on the surface locally.
- The amount deposited on aircraft and weapon debris.
- And the amount in and beneath the ice at the impact point.

Contamination associated with debris would be expected to be distributed beneath, in, and on the surface. Absolute determination of the quantities of contamination associated with each of these vectors or modes of dispersal and deposition was essentially impossible. However, from the practical viewpoint, the most important considerations at Thule were the amount, form, and fixation of plutonium and tritium on the surface in the immediate vicinity of the crash site and in the refrozen ice at the impact point where decontamination operations were technically feasible.

The speed of the plane at impact was in excess of

609

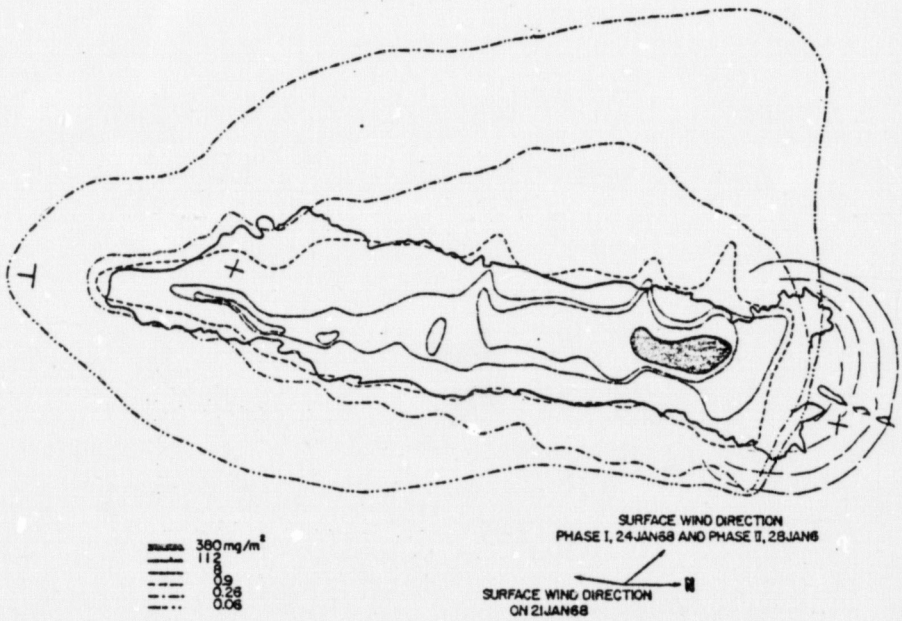


Figure 1 Plutonium contamination levels observed.

500 knots. Its gross weight was about 410,000 pounds—this included about 225,000 pounds of JP-4 fuel. The shallow impact angle and mass and speed of the aircraft resulted in a great forward vector of momentum. When the high-explosive components of all four weapons detonated, the contamination was blown out in all directions and impinged into the materials of the weapons and the aircraft and blown into the splashing, burning fuel. The fuel and much of the debris from the aircraft were catapulted forward on the surface of the ice. When the burning fuel fell back to the surface the fire was soon extinguished, leaving the blackened refrozen crust on top of the snow pack (Figure 1). The ice was completely shattered and disoriented at the impact point and sustained circular cracking out to a distance of about 100 yards in all directions. The peculiar markings on the ice showed the drag and destruction of the left wing, from this the crash attitude of the plane was deduced. From momentum considerations and the pattern on the snow pack, one would expect to find a large fraction of the surface contamination confined to the blackened crust where it was fixed by refreezing of the melted surface. This was indeed found to be the case.

The remainder of the contamination was dispersed in the smoke plume, impinged on the debris of the bombs and the aircraft, and blown into the ice at the site of impact.

CONTAMINATION OF THE SURFACE

Plutonium Distribution and Amount. Simple autoradiographic studies, as well as instrument measurements, established unequivocally that the depth-distribution of plutonium in the snow pack was strictly a function of the depth of blackening and melting of the surface. Over a large part of the blackened area, this depth was no more than about one-half inch. More plutonium contamination was found and its distribution was to a greater depth in those areas where more fuel collected and burned, resulting in more melting of the snow pack. In the most highly contaminated area, the snow pack had melted down to the surface of the ice. Surface distribution of plutonium (other than that adhering to large pieces of aircraft debris which were picked up) is shown in Figure 1. The contours were established by the monitoring teams using the Lawrence Radiation Laboratory Field Instrument for Detection of Low Energy Radiation (LRL FIDLER instrument). Because of the variable thickness of the overburden of ice and snow (complicated further by the two phases of 25 and 28 January), it was necessary to apply different calibration factors to the instrument readings for the areas within each contamination contour. As an example, where the contamination level was highest (380 mg/m²) more fuel had burned and the snow pack had melted down to and even into the ice. Upon refreezing, the

610

TABLE 1

Distribution of plutonium on the surface in the vicinity of the crash (excluding that picked up on aircraft debris).

Contamination Boundary (mg/m^2)	Enclosed Area (m^2)	Plutonium (g)	Deposition* (%)
380	1.97×10^3	845	27
112	1.10×10^4	2816	89
8	2.49×10^4	3014	96
2.4	3.90×10^4	3079	98
0.9**	5.97×10^4	3109	99
0.26	1.10×10^5	3135	99+
0.19	1.34×10^5	3140	99+
0.06	2.23×10^5	3151	100

*Total out to the specified boundary.

**Edge of the blackened area.

absorption characteristics for the soft X rays from plutonium and americium were quite different than where little depth of melting and refreezing had occurred. Absolute contamination levels were obtained by taking representative samples in each contour area subsequent to a careful instrument reading and returning them to Los Alamos for plutonium and americium analysis. Total amounts of plutonium were obtained by integrating the surface concentration as a function of area (Table 1).

The plutonium values are probably good to ±20 per cent out to the edge of the blackened crust area, which corresponded roughly with the 0.9-mg/m^2 contamination contour. This information indicated 3150 ±630 g of plutonium on the surface (excluding that picked up on aircraft debris), of which about 99 per cent was in the blackened pattern and would be removed by removing the snow pack over this area. Assuming removal of the crust and packed snow to an average depth of 4 inches, the volume removed would be 6000 m^3 (1.6×10^6 gallons). Assuming further that the volume ratio of packed snow to water is approximately 2.5, this would constitute about 6×10^5 gallons of water, which would contain between 2500 and 37 b of plutonium.

Plutonium-Form, Particle Size and Fixation. It was felt that the ultimate distribution of the plutonium in the event large amounts of the blackened crust were allowed to break up with the ice and go into North Star Bay might be influenced by its form, particle size, and fixation. Detailed nuclear track autoradiographic and microscopic studies of melted crust samples were conducted to obtain pertinent information. These studies showed the plutonium to be in the form of oxide particles with a very wide size distribution. The count median diameter was 2 microns, with a standard deviation of about 1.7. The calculated mass median diameter was about 4 microns. The particles were associated with or adhering to particles and pieces of inert debris of all kinds (metal, glass and nylon fibers, plastic, rubber, flecks of paint, etc.) of all sizes. The mass median diameter of the inert particles with which the plutonium was frequently associated appeared to be at least 4 to 5 times larger than the plutonium particles themselves. Many of the melted crust samples showed the presence of unburned jet fuel. A very crude estimate suggested that as much as 18 per cent (4×10^6 pounds) of the fuel may have remained unburned in the blackened crust. Sedimentation studies showed that up to 80 per cent of the plutonium was associated with low specific gravity debris that remained suspended in the jet fuel. The general feeling was that this fact increased the probability of contamination of the shoreline should the blackened crust be allowed to melt and enter the bay.

Tritium—Form, Distribution, and Amount. Laboratory examination of samples of the snow pack from the blackened area showed the presence of tritium oxide confined largely to the depth of the blackened crust. As water, a major fraction of the tritium contamination would have been expected to be carried away and dissipate with the smoke plume. Only that would remain which condensed on surfaces and nuclei that were rapidly cooled to the ambient temperature (-25° to -35°). The tritium fixed in and on surfaces in this manner would be expected to dissipate at rates that would fluctuate with temperature and wind conditions.

It is not possible to establish tritium surface deposition levels with field monitoring instruments because of the extremely low energy (17.9 kev maximum) of the beta radiation it emits. To determine the amount of surface tritium contamination present with any degree of certainty would have required an extensive and intensive sampling program which hardly seemed justified under the circumstances. It was considered adequate, therefore, to determine tritium in a relatively few samples of the blackened crust to confirm its presence and to establish the magnitude of contamination as assurance that no personnel exposure problems would occur during the operations. Analyses of these samples were considered representative of the areas within the plutonium contamination boundaries (Figure

Table 2

Distribution of tritium on the surface in the vicinity of the crash (excluding that picked up on aircraft debris).

Plutonium Contamination Boundary (mg/m^2)	Enclosed Area (m^2)	Tritium (curies)	Deposition* (%)
380	1.97×10^3	365	27.2
112	1.10×10^4	657	49.1
8	2.49×10^4	986	73.7
2.4	3.90×10^4	1337	100

*Total out to the specified boundary.

611

1) from which they were taken. Integration of the tritium levels within these boundaries gave a very crude estimate of the distribution and total amount of tritium within the blackened pattern. The results are shown in Table 2 and suggest a total of approximately 1350 curies of tritium confined to the area in the form of tritium oxide. The estimates are probably accurate to ± 50 per cent. This amount of tritium would have to be diluted into only 4.5 x 10 m³ of water to be at the maximum permissible concentration for continuous consumption.

CONTAMINATION IN THE ICE AT IMPACT POINT

The ice at point of impact was approximately 3-feet thick. Impact of the plane and detonation of the high-explosive components of the four weapons on board completely fractured and displaced the ice over an area of about 2100 m² (46 m x 46 m). The ice sustained circular cracking without displacement out to about 100 m from the impact point. Isotropic propagation of the shock wave from the high-explosive detonation accelerated a fraction of the contamination and debris from the disintegrating aircraft in the downward direction, impinging it into the fracture area. When fractured, the pieces of ice were displaced downward into the water, randomly oriented, and returned to the surface where they refroze in position. The attitude of the plane at impact was such that essentially all of the fuel was forward and above the weapons. This would be expected to result in the majority of the fuel and contamination entrained from a large solid angle being accelerated up and forward on the surface of the ice by the dominant forward momentum. The general feeling, however, was that additional information regarding amount, distribution, form, fixation, etc., of the contamination of the fractured area was desirable before making decisions as to its ultimate disposition.

Plutonium—Distribution and Amount. A closely spaced core sampling grid was laid out over and around the fracture area (Figure 2), and 49 full thickness core samples were taken and examined. These cores were studied visually and microscopically and were scanned inch by inch with monitoring instruments. Representative cores were transported to Los Alamos for further study and chemical analyses for plutonium as a means of standardizing the scanning measurements made at Thule. Results showed that the plutonium contamination was usually confined to a narrow band which often could be detected visually because of the associated debris from the disintegrated aircraft and bomb casings. The band of debris with the associated contamination was sometimes on the bottom of the core, sometimes on the top, and sometimes displaced from either end. Some cores showed diagonal bands and others no bands at all. These observations reflected the fact that the fractured ice was displaced downward, returned to the surface, and refrozen in a more or less random pattern with respect to the reconstituted surface.

The fact that cores were scanned inch by inch permitted a crude statistical estimate of the depth-distribution of the plutonium in the ice. It appeared that about 13 per cent of the total plutonium in the crushed and refrozen area was in the top 2 inches, 36 per cent was in the top 4 inches, and 45 per cent was in the top 6 inches. About 15 per cent was in the bottom 10 inches. The remaining 40 per cent was distributed between 6

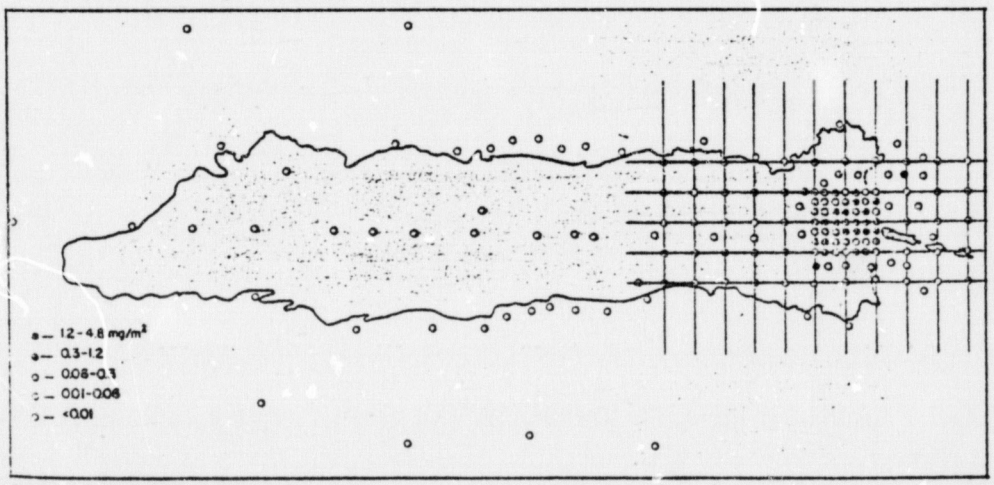


Figure 2 Ice core sample locations.

6/12

inches from the top and 10 inches from the bottom.

The plutonium distribution pattern, in terms of contamination per m² of surface area, was highly erratic, and it was not possible to represent the results by any simple contour pattern (Figure 2). There was a tendency for the most highly contaminated cores to extend to the back and sides of the center of impact, which might be expected from the relative position of the bombs with respect to the main body of fuel and the crash attitude of the plane. However, cores of comparatively low radioactivity were interspersed among the most radioactive cores, suggesting a highly segregated pattern probably related to reorientation of blocks of ice by the force of the impact and explosion. The random orientation of the rectangular grid with respect to the crushed ice pattern supports the assumption that the cores were statistically representative of the primary impact area in terms of total plutonium and range of local concentrations. Results from the 49 cores showed that 16 per cent contained 65 per cent of the contamination and 52 per cent contained 97 per cent. An estimate of the total amount of plutonium in the fractured ice area (~ 2100 m²) showed about 350 g. The accuracy of estimate was probably ~ ±25 per cent. The amount of plutonium in the ice would have to be dispersed in about 5×10^4 m³ of water to be at the maximum permissible concentration. This is about 60 times the water volume produced by the melting of the porous ice itself.

Plutonium—Form and Fixation. It was felt generally that information on form and fixation of the plutonium in the fractured area might have bearing on questions regarding its ultimate availability to local ecological chains. Microscopic and autoradiographic observations of the residues filtered from melted ice core samples showed fine particles of plutonium oxide impinged into or adhering to pieces of aircraft and bomb casing debris of all sizes. The blackened bands in the ice cores consisted of small pieces of metal, rubber, fiberglass, paint, plastic, etc., up to 1 mm in size to which the plutonium oxide particles were fixed. Sedimentation studies of melted ice cores showed that 85 to 95 per cent of the debris and associated plutonium oxide sank immediately. No JP-4 fuel floated on the surface; only a thin film of fine carbonized material. The remainder of the plutonium was retained on the surface associated with this carbonized film. Only about 1 per cent was suspended through the water phase as very fine particles. This rapid settling of most of the plutonium greatly decreased the possibility of shoreline contamination from floating debris subsequent to melting of the ice.

Tritium—Form and Amount. Only a very few cores from the crushed ice area at point of impact were examined for tritium contamination. The contamination was in the form of oxide, and the amount appeared to be of the order of 17 mCi/m³ assuming the ice averaged 1 m in thickness. This value, multiplied by the area (2100 m²), suggested a total of only about 35 Ci of tritium activity in the ice at the point of impact.

CONTAMINATION BENEATH THE SURFACE

A very difficult question involved the possibility that contamination might have been dispersed beneath the ice in a form that could reach the shoreline or be concentrated by some biological process in the local food web. Two possible modes of contamination and dispersal beneath the ice were proposed for examination.

One possibility was that a pool, or pools, of highly contaminated fuel might have been trapped beneath the surface near the impact point. To examine this possibility the field teams took an additional 133 core samples, 85 on a grid pattern around the fractured area and over the blackened surface pattern and another 48 outside the periphery of the pattern (Figure 2). None of these cores showed any contamination on the bottom end, and no jet fuel or other floating debris was forced up through the core holes by the hydrostatic pressure beneath the ice.

The second possibility considered for plutonium to have gone beneath the ice was in connection with contaminated aircraft debris that might have been blown through the ice and sunk to the bottom. Pieces of the aircraft found on the surface were transported to Los Alamos to observe the amount, form, and fixation of the associated plutonium contamination. No tritium observations were attempted. Debris consisted of pieces of steel, aluminum, and other materials. Some pieces were highly contaminated on both sides, others on only one side, and still others showed hardly any contamination at all. Due to the numerous unknown quantities and inherent inaccuracies, no attempt was made to determine from the contamination observed on the debris the amount of plutonium that might have gone through the ice. However, later underwater observations during the summer season, dealt with in a separate article in this magazine, established that the aircraft debris which penetrated the ice was stabilized on the ocean floor.

Microscopic and autoradiographic observations showed that the contamination on the pieces of debris consisted of particles of plutonium oxide impinged into or adhering to the surface. Lavation tests in sea water were conducted on contaminated pieces of steel and aluminum to determine removal as a function of time. Different rates were observed for different materials, as well as for different pieces of the same material. The observations supported what might be expected, i.e., that removal rate would depend on the nature and hardness of the surface and velocity of the impinging particles, which would be dependent on the distance of the surface from the detonation. In any event, these observations suggest that, if indeed a large amount of plutonium was carried to the bottom associated with aircraft wreckage, it would not all be released rapidly or at the same time. This would make the possibility of high concentrations at any given time very unlikely

613

ATMOSPHERIC DISPERSAL AND GENERAL AREA CONTAMINATION

The amount of plutonium and tritium taken up in the cloud from the explosion and fire and its distribution as long-range or general-area contamination were virtually impossible to predict with the available information. All available data, including cloud height, regional meteorological conditions at the time of the crash and for 10 days after, pyrotechnic information, etc., were sent to the Sandia Laboratory for consideration in view of that organization's experience with nonnuclear detonation experiments. These field tests have resulted in the development of detailed data and calculational models for estimating deposition patterns and contamination levels from nonnuclear detonation of plutonium-bearing weapons. The principal parameters needed are source strength, aerosol characteristics, high-explosive yield, and detailed local and long-range meteorology. Unfortunately, conditions at Thule were such that several of these parameters were either obscured, unknown, or unpredictable. Based on the inadequate information and several assumptions, the Sandia Laboratory was able to draw three general conclusions which are summarized as follows:

- Deposition of the aerosol produced initially would have been expected in a west-southwesterly direction on open ice and Wolstenholme Island. No deposition levels could be estimated, since the source term was obscured by the crash conditions and aerosol characteristics were unknown. However, the original long-range deposition pattern would be expected to be changed under the prevailing phase conditions during the first few weeks after the crash.
- Wind-resuspended contamination probably traveled around and possibly over Saunder Island. However, the condition responsible for the transport made redeposition of much activity on the island unlikely.
- The levels of long-range contamination expected would be radiologically insignificant but, because of the inherent sensitivity of chemical methods, plutonium should be detectable in surface samples taken south and west of the crash site.

Plutonium analyses of surface samples from the principal land masses in the general area are presented and discussed in another article in this magazine.

SUMMARY AND CONCLUSIONS

Immediately following the Thule incident a technical and laboratory support effort was mobilized to comply with requests by the field commander, expert committees, and policy-setting groups for additional technical information and consultation. This effort contributed, in part, to the following factors thought pertinent to the Thule situation:

- Laboratory calibration of field instrument readings and integration of deposition contours at the crash site suggested that the amount of plutonium on the surface was 3150 ± 630 g, approximately 99 per cent of which was confined to the blackened pattern on the snow pack. The plutonium in the crust was in the form of oxide particles, often associated with larger particles of low density inert material which tended to remain suspended in unburned JP-4 fuel. Tritium contamination in the form of tritium oxide was found on the surface largely confined to the blackened crust. The amount present was estimated at about 1350 Ci ± 50 per cent. These observations suggested that removal of the blackened crust and its associated plutonium contamination was desirable.
- Laboratory analysis of representative ice cores taken from the fracture pattern at the impact point, which were related to field instrument scans of other cores from the area, gave an estimate of 350 g of plutonium trapped in the ice. Reorientation and refreezing of the broken ice resulted in a segregated contamination pattern both with respect to depth and area. In this area also, the plutonium was in the form of oxide particles associated with inert debris from the bombs and aircraft. There was little or no unburned jet fuel, however, and upon melting of the ice the contamination did not float or remain suspended. This fact was further assured by covering the entire fracture area with black carbonized sand, which in addition to accelerating melting of this area, absorbed and sank any jet fuel film that might have remained afloat to suspend contamination. The estimated amount of tritium (as the oxide) trapped in the ice at the impact point was about 35 Ci. These and other factors, such as distance of the impact point from shore and depth of the bay, suggested that it was unnecessary to remove the approximately 2,000 tons of ice involved.
- Projection of contamination through and beneath the ice at impact point was considered also. Additional core drillings made throughout the general area of the crash failed to reveal any floating pools of jet fuel trapped beneath the surface.

All contaminated large pieces of aircraft wreckage on the surface were picked up and confined. Laboratory studies were carried out to determine the form, fixation, and lavation rates of plutonium from the surfaces of wreckage. These studies suggested that, if indeed large pieces of contaminated wreckage had broken through the ice and sunk to the bottom, there was little likelihood that high concentrations of plutonium could enter some aquatic factor of the local food web.

- Attempts to calculate meteorological transport and deposition of long-range contamination, although quantitatively unsuccessful, did suggest that contamination levels on land masses south and west of the crash site would be radiologically insignificant but probably measureable by chemical analysis of surface samples.

614

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK, PLAINTIFF
v.
THE NUCLEAR REGULATORY COMMISSION, et al.
DEFENDANTS

STATE OF GEORGIA)
COUNTY OF FULTON) ss.:

KARL Z. MORGAN, being duly sworn, deposes and says:

I am very much opposed to air shipments of other than exempt quantities of plutonium and other dangerous actinide elements. I strongly endorse the statement of the Special Panel to Study Transportation of Nuclear Materials to the Joint Committee on Atomic Energy -- Congress of the United States (September 17, 1974). I am a member of this panel and a portion of the text to which I refer is, "The panel recommends that the AEC and DOT prohibit the shipment by air--air cargo as well as passenger aircraft--of other than exempt quantities of plutonium and other Transport Group I material unless a determination is made that the air shipment is necessary for the security of the Nation. The danger of an aircraft accident and resulting risk of contamination from plutonium, other actinides and other Category I material is sufficiently grave as to warrant their total restriction to ground and water transportation."

I am of course acutely aware of the wide divergence of opinion among scientists, regarding the risks associated with plutonium, but most of those who depreciate these risks have not had first hand and practical experience with these radionuclides.

So far as I can determine I was one of the first persons (if not the first) to publish a paper calling attention to the risks of these radionuclides (KZM, J. of Physical and Colloidal Chem. 51, 984-1003, 1947), indicating how to calculate the permissible exposure levels and giving

615

suggested body burdens and environmental concentrations of Pu-239 and other similar radionuclides. I was a member of the Chalk River, Canada Conference in 1949 that first set the low levels of maximum permissible concentration of these radionuclides and was chairman of the Internal Dose Committees of the International Commission on Radiological Protection (ICRP) and of the National Council on Radiation Protection (NCRP) from their beginning until recently (about 1972) and am still actively concerned with these problems as a professor of Health Physics and Nuclear Engineering at Georgia Institute of Technology. From 1943 to 1973 I was director of the Health Physics Division of Oak Ridge National Laboratory, Oak Ridge, Tennessee where I had extensive experience with plutonium and published many papers relating to the associated risks and protection measures for plutonium. I refer here to my latest publication on this subject, "Suggested Reduction of Permissible Exposure to Plutonium and Other Transuranium Elements" (J. of Amer. Industrial Hygiene 36, scheduled for publication in June or July 1975). In this and other publications I have called attention to related matters such as the following:

1. The present maximum permissible body burden of Pu-239 based on dose to the bone should be reduced at least by a factor of 240 i.e. from 0.04 millionths of a curie to 0.00017 millionths of a curie (Note: A curie of Pu-239 equals approximately 15 grams.).
2. There are contradictory data regarding the risks of Pu-239 when contained in small so-called "hot particles" of the order of 1 μm mean diameter and until more data are obtained great caution should be applied in using the present maximum permissible body burden of 0.015 millionths of a curie in the body as a result of inhalation. The above values are for the occupational worker and should be lower at least by a factor of 10 when applied to

616

members of the public at large where there are children and others more susceptible to radiation damage.

3. I have considerable reservations regarding the appropriateness of assuming only 3 parts in 100,000 of Pu-239 ingested is taken up into the blood stream of man as is presently assumed by NCRP and ICRP. During the period I was at Oak Ridge (1934 to 1973) I saw many examples where supposedly very insoluble compounds of radionuclides were ingested or inhaled and the uptake into the blood was 100 or more times that assumed in the usual calculations of NCRP and ICRP.

4. There is great uncertainty regarding the consequences of Pu-239 in the pulmonary lymph nodes and this risk is discounted in present calculations although the concentration in these nodes is known to be 10 to 100 times that in other parts of the lung or the bone.

5. There is considerable evidence that for chronic exposure to Pu-239 the ultimate risk may be to the liver and yet this risk is not taken into account in the present permissible exposure levels of NCRP and ICRP because of lack of sufficient human data.

Environmental plutonium contamination can be very costly not only in potential cancers that may be a consequence 10 to 50 years later but in terms of dollars cost of cleanup. While I was at Oak Ridge, there was a chemical explosion of a tank containing some plutonium and the total cost of cleanup I would guess was over $100,000. First we tarred the roads near by and sprayed paint on the buildings within about 100 yards to hold down the plutonium. Then we took up the road piece-by-piece; put it in plastic bags and buried the bags in a properly selected burial ground. Later we did the same with the nearby two story building, i.e. sawed it in pieces and buried

617

it. Also I was indirectly involved in the plutonium cleanup from the aborted weapons that contained plutonium which contaminated some of the environments of Portugal and Greenland. I do not have the figures on the total cost of cleanup in these two accidents but I would not be surprised if it was in the millions of dollars.

I do not believe I as a health physicist or as a tax payer should continue the risks related to a potential air crash at a large airport of a plane carrying appreciable amounts of plutonium.

Karl Z. Morgan

Karl Z. Morgan, Neely Professor
School of Nuclear Engineering
Georgia Institute of Technology
June 6, 1975

Lydia S. Geesler

Notary Public, Georgia, State at Large
My Commission Expires July 13, 1977

618

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK, -v- Plaintiff NUCLEAR REGULATORY COMMISSION, et al., Defendants.	AFFIDAVIT 75 Civ. 2121 WCC

STATE OF VIRGINIA)
: SS.:
CITY OF NEWPORT NEWS)

I. IRVING PINKEL, being first duly sworn, deposes and says:

1. a. I am an engineering consultant, recently retired from a 37-year professional career in the scientific service of the U. S. Government. Thirty-two of these years were spent with the National Aeronautics and Space Administration (NASA) and its predecessor organization, the National Advisory Committee for Aeronautics, which was devoted to aeronautical research. From 1955 to 1968 I was a research division chief with supervision over more than 100 professional engineers and scientists studying aviation and space flight systems.

b. From the years 1949 to 1960 I supervised the flight research activities of the Lewis Research Center (NASA/NACA). During these years a portion of the flight research was devoted to flight safety. This work included a massive study of airplane crash survival in which extensive laboratory studies on fire and impact loads were supplemented by over forty carefully instrumented, full-scale crashes of airplanes which duplicated landing and take-off accidents. This work is documented by reports and motion pictures available from NASA/NACA. Because of the insights gained from this work on the mechanics of the start and spread of

aircraft fires and aircraft crash loads, I was asked to serve on several military and civil accident review teams. I was also a principal investigator of the Apollo fire, and served as an observer on the team which investigated the on-board explosion which occurred during the flight of Apollo 13. For four years prior to my retirement from NASA in 1972, I was the Director of the NASA Aerospace Safety Research and Data Institute. Additional biographical data is appended.

2. This affidavit is prepared and submitted in support of the plaintiff's motion for preliminary injunction in the belief that the presently used containers are inadequate to the air crash environment and that appropriate and adequate containers are feasible within the current state-of-the-art, and within reasonable economic bounds, and finally that to continue use of the present containers unnecessarily and unreasonably jeopardizes both extensive human life and the continued progress of the nuclear program.

3. This affidavit has been prepared in coordination with and with the concurrence and support of two other persons with background and experience in the aspects pertinent to aircraft safety and design for crash survivability. They are F. P. McCourt and Larry M. Hewin, who are members of F. P. McCourt and Associates, Aviation Safety and Management Consultants of Newport News, Virginia. Biographies are appended.

4. It is my view that the containers for the shipment of special nuclear materials are inadequately engineered to protect against the spill-threat of these materials involved in airplane shipment. While the likelihood of accident to an individual shipment may be computed to be small, the consequences of a spill are awesome. Not only are the people exposed to contamination threatened, but the whole development of the nuclear power industry

world-wide would be jeopardized by the news that a spill occurred, however few the resulting casualties. It is in the interest of the nuclear power industry to apply its best technology to ensure that the chance of a nuclear material spill is as near to being totally eliminated as current technology will permit. To do less is tantamount to negligence.

5. a. To argue that the chance of an airplane accident is small and that a nuclear material spill from the present container in such an accident is also small so that one can ignore the residual risk is a fallacious position for responsible people. With the marked increase in the volume of such shipments, the probability of becoming involved in an accident is growing. Likewise, the nature of the threat to the container has been inadequately defined and the test requirements for the containers are arbitrarily chosen.

b. To put this matter in perspective, one ponders what probability would have been computed for losing a passenger from the cabin of a modern airplane in flight, such computation being made prior to placing such aircraft in service. Then consider the much reduced probability that would have been computed that a passenger securely fastened with seat belt would be lost. Yet, seat-belted passengers have been lost from flying aircraft.

c. Likewise, one would probably compute an exceedingly small probability of inadvertently dropping a nuclear weapon from a military airplane, considering the multiple safeguards that such weapons carrying systems must have. Yet two bombs were dropped into the waters off the coast of Spain. The marked

reaction of the Spanish people, their government, and safety-minded people everywhere was enormous, even though no nuclear detonation occurred.

d. When the consequences of failure are disastrous, and public anxiety about nuclear contamination amounts to hysteria, one is obligated to provide the best containment for nuclear materials in shipment consistent with reasonable means for handling them. The remarks made in this affidavit are intended to support the plaintiff's motion for preliminary injunction in order to prevent a potential disaster to human life and to the nuclear program; and ultimately promote the movement of nuclear materials through improved handling safety.

6. On the basis of the NTSB information on commercial carriers with which I am familiar, I doubt that there is enough documentation on the damage to air cargo adequate enough to be a reliable source of design criteria for containment vessels. This documentation appears to be the source of these criteria used for the present design. A more adequate description of the threat to the containment vessel, and hence its design requirements, should be drawn from the total aviation experience. In doing this one must deal in substantial matters and avoid the trivial. The following is my judgment of the substantial threat to the container, along with some concepts regarding test and protection:

a. Because cargo can be lost from aircraft in flight, the container must be able to withstand ground impact at free-fall terminal velocity. Such loss can occur from failure of the cargo compartment by mid-air collision, structural failure by fatigue in heavy turbulence, and intentional or accidental explosions.

b. In many crashes the cargo bay is compressed by deformation of the understructure. Some cargo is likely to be subjected to crushing loads. The nuclear material container should be designed structurally to support such loads without destroying the inner vessel containing the nuclear material or losing the fire protection for the inner vessel. While a design crushing load is difficult to specify since it varies with the circumstances of the accident, it is important that the structure be shaped to support the maximum load consistent with reasonable size and weight, and be consistent with convenient handling. Attachment locations for lifting a damaged container from an accident without increasing the vessel damage should be provided.

c. Fire exposure following crash impact damage should be to a 1800°F. - 2000°F. flame directed to impinge on the container in an air stream moving at 5 miles per hour. At least one-third of the container surface should be covered by the flame which shall endure for 30 minutes. (For containers which must carry liquid nuclear materials, a heat sink should surround the inner vessel containing such liquid to avoid vessel rupture by over-pressure of the heated liquid.)

d. Heat insulation should remain in place and continue to function even when the outer container shell is breached or crushed.

e. Damage to inner vessel by projectiles or spear-like objects should be expected and can be prevented by shaping the outer vessel to deflect them. Also, a layer of material operating on the principle of a lightweight flak suit or bullet-proof vest should surround the inner vessel to defeat any object that penetrates the outer vessel. The piercing objects might be

fragments of engine turbine wheels, other tightly packaged cargo or hydraulic system components which explode in the heat of the crash-fire, and elements of failing airplane structure or ground obstacles. Containment vessels that can handle these threats can also cope with small arms fire from the ground which occurs frequently enough to transport aircraft to be of interest in this issue.

f. It is important to the recovery of a shipment of nuclear material lost into water that the container shall float even though the outer vessel is breached.

g. Resistance of the containment vessel to corrosive agents should be demonstrated if shipment is allowed without restriction as to other adjacent cargo.

7. a. The present containment vessel was designed to treat with only a few of these threats, and for these the magnitude of the threat has been underestimated. For example, testing the integrity of the outer vessel in ground impact after a free fall of 30 feet hardly corresponds to the case of impact at terminal velocity. In the case of the Sandia drop tests mentioned in the Nussbaumer affidavit, an impact at 130 feet per second did in fact damage the inner vessel. This impact speed is considerably less than the terminal velocity. In the Sandia report of these tests entitled, "Special Tests for Plutonium Shipping Containers," by L. F. Stravasnik, September 1972, the observation is made that if the impact speed were raised slightly, an additional 20 feet per second, spillage of the nuclear material is likely.

b. Likewise, the use of a short, blunt 6-inch diameter penetration probe impacted from a 40-inch drop does not approximate the penetration damage potential of the shrapnel-like fragments shed by a disintegrating turbine wheel or a heat-pressurized hydraulic component that exceeds the burst point in the crash-fire. In the tests conducted to qualify the present containment vessel no thought was given to this ballistic type of penetration. Protection against such penetration is available now that could be accommodated to the space inside the outer containment vessel no matter what is its shape. Spear-like penetrants that pierced the outer containment vessel would be blunted and defeated by the same arrangements.

c. Also, there is no attempt to contour the outer vessel to deflect the penetrant and reduce the probability of piercing its wall. This technique is usually exploited by those who understand the engineering of protective devices (example: as in aircraft armor).

d. With regard to fire protection, the arrangements in the containment vessel are found to be weak in two respects. First, if a wide breach in the outer vessel occurs, the loose vermiculite (or equivalent granular insulation) can pour out through the opening with a consequent loss in fire protection. Second, if the outer vessel is breached the present loose insulation allows water to enter. Floatation is lost, and the containment vessel would sink if it fell into water. Search and retrieval would be much more difficult if it sinks.

e. Application of good, available technology would probably show foamed-in-place, closed-cell, insulation that fills

all the voids between outer and inner vessel. The foam would have excellent heat insulation and would have the added quality of forming a flame-impervious char wherever the outer vessel has been penetrated. The foam would also prevent the penetration of water and preserve floatation.

f. From the standpoint of withstanding a crushing load, the present outer vessel, which is a standard 55-gallon drum, is exceptionally poor. Better use of the same weight of material would show shapes that approximate a sphere rather than a cylinder with corrugations around its sides and with flat ends.

g. In the matter of the protection of the inner vessel in impact at terminal velocity a quality engineering approach to the problem would include:

(1) A better structural shape for the outer vessel, approximating a sphere or elongated sphere (aerial bomb shaped).

(2) A low center of gravity to fix the point of impact with the ground. If this is done the vessel wall thickness around the impact zone can be heavier than the rest of the vessel to lend added strength. Energy-absorbing material can be firmly attached to the outside surface of the vessel to cushion the impact, and reduce the danger of penetration of the vessel by blunting the edge of ground-supported sharp penetrants. The foamed-in-place heat insulation properly modified, could provide additional energy absorption for protecting the inner vessel.

(3) Aerodynamic fins to stabilize the containment vessel to fall with the heavy end foremost to ensure where impact occurs. Additional finning can be added to provide high

aerodynamic drag to reduce the terminal velocity. The fins can serve as safe points of attachment for moving the containment vessel in its original or damaged configuration.

(4) Energy-absorbing structure would be used for supporting the inner vessel. There are many methods developed for doing this that can be adapted.

h. The present containment specifications show no concern for exposure to corrosive agents that might spill in the same accident. Failure by corrosion of the outer and inner vessels might occur in a crash in an area difficult to reach so that a long corrosion time is possible. There are paints which weather well that provide corrosion protection. Some of these might have the additional quality of intumescing when exposed to fire to a heat-insulating porous char to enhance the fire protection. If such paints are considered impractical, then at least the inner vessel should have a stainless steel cladding on the basic mild steel surface to provide corrosion protection.

i. In the past twenty years there have been significant advancements as a result of military developments, in light weight materials with great resistance to ballistic penetration; there have been advancements in heat resistant and absorbant (intumescent) materials for fire protection; and advanced structural concepts and materials for energy absorption developed from aviation crash research and from space programs. None of the foregoing are apparent in the series of designs. Compare this with the enormous effort NASA expended in providing a container for a small radioisotope package to be carried to the moon on the Apollo space craft. The container was required to hold the radioactive contents through the high heating of atmospheric

627

reentry and sharp ground impact in the event of a flight abort. I was part of a NASA team charged with the development of this container and was party to the advanced material development and container design. Computation and testing of near heroic proportions supported this work. The NRC attitude on the 6M container, which is an equivalent problem, must be regarded as casual by contrast. It is apparent that antiquated technology is being applied to a problem which cannot afford any less than the best.

3. In summary:

a. The assumptions of the defendants about the air crash environment are inadequate. Therefore, the spec's for qualifying containers, based on those assumptions, are inappropriate. They should be more stringent and based on realistic appraisal of aviation experience and research results over the past years. The containers now in use are clearly <u>not</u> designed from a complete knowledge of the crash environment nor do they utilize the best of current state-of-the-art technology for protecting articles or occupants in the air-crash environment.

b. It is considered feasible and practical, from an economic and engineering viewpoint and considering only currently available technology and techniques, for the defendants to design and build a container that would have virtually zero probability of releasing its contents in a "worst case" aircraft accident. As indicated above, the present containers fail completely to meet these objectives. To continue to utilize them in routine air shipments is to needlessly jeopardize human life and to risk the possibility of generating extremely adverse public reaction.

c. The defendants, in their affidavits, have, in addressing the probability of release of hazardous material to an extent causing extensive deaths, utilized such terms as "remote" and "small." The point is that even events with "remote" possibility do occur and in the aviation field, have occurred. The thing that must be kept in view is the dimensions of the consequences. Even if the most severe set of casualties is less than the 100,000 estimated by Dr. Resnikoff and is 10 times less as estimated by the affidavit of Barker, the consequences are awesome -- and the probability should be reduced from remote to virtually zero. The fact that no significant accident has occurred can only be considered fortunate. In statistical probabilities, a one-in-a-million chance event may not occur until the two millionth trial, but it may also occur on the first trial. My belief is that we cannot afford the "worst case" consequences whenever they occur, and that proper design can avoid them.

d. The present practice of routinely utilizing a container that has experienced some failures even when tested to a specification that is inadequate, while depending on the remoteness of the probability of calamitous combinations or factors, would be a doubtfully acceptable risk even if no better engineering solution were available. When it is considered that the past twenty years of aviation research and testing have provided volumes of knowledge with regard to both the hazards and how to protect against them, the use of anything less than optimum design borders on negligence.

e. It can only be surmised that the vast size and complexity of compartmentalization of the federal government has

thus far prevented the cross coupling of appropriate bodies of knowledge to provide an adequate container.

f. I believe, therefore, that it is in the best interest of all parties that shipments by air utilizing the present containers be terminated and that the defendants be directed to initiate an accelerated program of development of a suitable container.

g. Although the surface transportation accident rates are higher than those of air transportation, the surface modes do not involve the higher velocities and other significant elements present in air operations and the present containers are believed to be more appropriate to the surface modes; their appearance suggests that they may have been designed for rail transportation or to rail transportation practices. Thus, surface modes of transport could suffice while the container designed for air is developed. At the same time, there appears to be every reason to believe that the container developed for aviation (as the most severe case) would be generally suitable for all modes.

I. Irving Pinkel

I. IRVING PINKEL

Subscribed and sworn to
before me this 10th day
of June, 1975.

Mildred L. Jones

Notary Public

My commission expires;
NOVEMBER 15, 1975

630

I. IRVING PINKEL

Mr. Pinkel graduated with honors from the University of Pennsylvania in 1934, receiving a B.A. degree in Physics, and joined the government scientific service in 1935 as a physicist with the U.S. Bureau of Mines. In 1940, he joined NACA at the Langley Research Center to work on the mathematical analysis of non-stationary aerodynamic forces and airplane flutter. In 1942, he transferred to the Lewis Research Center to work on the hydraulics problems of aircraft engine lubricating systems operating at high altitudes.

In 1949, Mr. Pinkel was appointed Associate Chief of the Physics Division at Lewis, with responsibility for studies of aircraft operating problems. As a part of this work, full-scale airplane crash studies were conducted which resulted in means to reduce the incident of fire following aircraft crashes, and the development of a theory for the design of aircraft seats to withstand crash shock loads.

A mathematical theory for the design of supersonic nozzles which provides shock-free flow was developed under Mr. Pinkel's direction in 1948. He also contributed materially to the development of the theory of the "condensation shock" in supersonic flow. In 1952, he developed methods for obtaining the supersonic flow field around immersed bodies when heat is added to the flow.

Mr. Pinkel was appointed Chief, Fluid System Components Division in 1955. In this capacity he directed research for improving the performance of compressors and turbines for aircraft engines and space power generating systems, and turbopumps for rocket propellant systems. Presently he is Director of Aerospace Safety Research and Data Institute.

Mr. Pinkel was elected an an undergraduate to Phi Beta Kappa, Sigma Xi, honorary scientific society, and Pi Mu Epsilon, honorary mathematics fraternity. Among his honors are the Laura Taber Berbour Awared in 1956 "for the development of a system for suppressing crash fires", the Flight Safety Foundation Award in 1953 "for contributions to the safe utilization of aircraft" and the NACA Distinguished Service Medal in 1957. In 1963, he received the Sustained Superior Performance Award for NASA. He is an Ohio Professional Mechanical Engineer, has served on the former NACA Subcommittees on Meterological Problems, Icing Problems, Aircraft Fire Prevention, Flight Safety and the NASA Research and Technology Advisory Subcommittee on Aircraft Operating Problems. Mr. Pinkel is a Fellow of AIAA and a member of the New York Academy of Sciences. He has been a Special Lecturer, Case Institute of Technology Graduate School. In 1967, Mr. Pinkel served on the investigation team of the Apollo 204 accident and in 1970 was involved in the Apollo 13 accident review.

RESUME

FRANCIS P. McCOURT
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Newport News, Virginia 2[illegible]
Tel. No. (804) 874-0008

1931 - Present: Mr. McCourt has been actively engaged in both military and civilian aviation, multi-engine airplanes and helicopters and aviation research. Has continued to serve as a consultant in matters of aviation safety across the spectrum of the aviation community including civilian as well as military agencies. Presently operating the firm of F.P. McCourt and Associates, aviation safety and management consultants.

In 1974 Mr. McCourt completed 18 years of federal service at the United States Army's Aviation Research Laboratories at Fort Eustis, Virginia.

1950 - 1953: Served as Chief Air Operations for the Transportation Research and Development Command.

1957 - 1959: Served as the Chief Research Analyst Division analyzing and evaluating technological advancements and breakthroughs in aeronautical and aero mechanical and other engineering scientific areas and determine those having direct or indirect effects on current and future military concepts.

Also served as a Special Assistant and Advisor to the Director of Aviation and other higher authorities on programs having national significance i.e., flight safety, crash injury and other recommended flight safety practices which require extensive knowledge and experience in aviation research and development operations in the broader sense. The assignments required an astute ability to render sound and logical judgment with the minimum of a preparation.

1959: Mr. McCourt was appointed Program Manager and Project Engineer for the Aviation Crash Injury Research Program. Mr. McCourt established a program designed to make a recognized science of the technique of aviation crash injury research. A comprehensive crash injury investigator's course was established primarily to train medical doctors in this specialized field of accident investigation from a casualty producing rather than on accident causation viewpoint. This has helped immeasurably in relating injuries sustained to such factors as occupant restraint systems and general environment though the idea of dynamic crash testing of representative types was not a new one; however, Mr. McCourt

recognized that a program of this type, designed specifically to investigate a rising toll of injuries being sustained in helicopter accidents was necessary if medical personnel and aircraft designers and manufacturers were to learn more about the vertical component of force so prevalent in rotary wing accidents. In the ensuing 12 years an approximate total of 45 aircrafts were crash tested with a wide array of experiments aboard. These crash tests were fully instrumental and produced both photographic and oscillograph-type recordings which had been of immense value to design engineers. In order to force the attention of aircraft designers, manufacturers and operators on the efforts and results of the aviation crash injury research program, and to ensure incorporation of the program results into production aircraft on a timely basis, Mr. McCourt has spoken before groups of people assigned with all aspects of the aviation industry throughout the United States and abroad. The results of the program to date have been most gratifying. Many of the existing aircraft and safety practices have been modified to reflect the latest knowledge in this field.

1966 - 1970: He was appointed Chief of the Safety and Survive Ability of the Army Aviation Material Laboratories. He then planned and conducted research programs with special emphasis on personnel and aircraft safety and combat survive ability in all environments. Programs include development of aircraft systems, operational safety requirements, and criteria. Development of aircraft fire prevention studies and development of design for the reduction and elimination of post crash fires and further the development of passive counter measures against a wider array of weapons threats i.e., balistic, sensor-guided missiles and radar.

Mr. McCourt has published a number of technical publications and reports. He is the recipient of a number of national and international awards in the field of aviation safety.

LARRY M. HEWIN

Mr. Hewin has extensive experience in aeronautical research and development, in mechanical design and background as a military pilot, instructor, and operations officer.

From 1962 - 1974 he served as a Technical Director and Deputy Director of the Army's Aviation Material Laboratories at Ft. Eustis, Va., responsible for the planning and conduct of a wide variety of R & D projects from subsystems to complete experimental aircraft, supervising a staff of 320 professional and supporting personnel with an annual program ranging from 20 to 40 million dollars.

Between 1948 and 1962, Mr. Hewin served several years with the National Advisory Committee for Aeronautics as a designer of aeronautical research equipment. Then, after transferring to Ft. Eustis in 1951, he served as a Transportation Requirements Analyst (Air), Project Engineer, Branch Chief, Division Chief, Director of Aviation, and as Long Range Technological Forecast Officer.

Mr. Hewin served as a combat bomber pilot in WWI and has been awarded several military decorations. Following WWI he served as both instructor pilot and as operations officer at squadron and base level. He currently holds a single and multi-engine land commercial pilots license.

Mr. Hewin holds a B.S. degree in Mechanical Engineering from Clemson, M.S. degree in Administration from George Washington University and is currently continuing graduate work at the College of William and Mary.

He is an Associate Fellow of the Institute of Astronautic and Aeronautics, has been a member of, and Chairman of, several SAE committees, and has held a number of offices with the American Helicopter Society including Associate Technical Editor of the Journal. He has published a number of papers and lectured to professional societies here and aborad. He also served several years as a member of the NASA Subcommittee on Aircraft Operating Problems.

Mr. Hewin has received the Army's Meritorious Civilian Service Medal and numerous other awards for recognition of accomplishments and performance.

McCOURT, Francis P
8 January 1913

Item 17
Publications

1. McCourt, Francis P. Developments in the US Army Emulsified Fuels Program. Presented at the AIAA 4th Propulsion Joint Specialist Conference. June 1968.

2. McCourt, Francis P. Survivability of Aircraft and Tracked Vehicles. Presented to the Army Director of Defense Research and Engineering June 1968. Unpublished.

3. McCourt, Francis P. "Kitten in the Tank," Aviation Digest Magazine March 1968.

4. McCourt, Francis P. Aircraft Safety & Survivability. Presented at the Aviation Scientific Advisory Group (ASAG) meeting Fort Eustis, VA March 1968. Unpublished

5. McCourt, Francis P. Potential Military Uses of Emulsified Fuel. Presented at the Annual American Society of Mechanical Engineers meeting in Washington, DC March 1968.

6. McCourt, Francis P. Use of Emulsified Fuels in Aircraft. Presented at the Army International Air Safety Seminar, Williamsburg, Virginia December 1967.

7. McCourt, Francis P. Factors Influencing Aircraft Survivability. Presentation made to LTG Betts, Army Chief of Research & Development. May 1967. Unpublished.

8. McCourt, Francis P. US Army Aircraft Fire Hazard, R&D Activities. Presented at the Airline Pilot's Association Forum, Los Angeles, CA October 1966.

9. McCourt, Francis P. Safety and Survivability Damage Criteria. Presented at the American Helicopter Society Annual Meeting, May 1966.

10. McCourt, Francis P. Factors Influencing Survivability. (Classified, title unclassified). Presented at the Man-Mobility-Survivability Forum April 1967.

11. McCourt, Francis P. Reduction of the Fire Hazard in Aircraft. Presented at the Annual Society of Automotive Engineers meeting, April 1966.

12. McCourt, Francis P. Southeast Asia Environment and Influence on Military Mobility. (Classified, title unclassified.) Presented at the Mobility Forum. October 1964.

635

McCOURT, Francis P
8 January 1913

Item 17
Publications (continued)

13. McCourt, Francis P. Operational Problems of Helicopters in the Army. Annals of the New York Academy of Sciences, Vol 107, Art 1, March 1963.

14. McCourt, Francis P. Safety is a Commodity. Presented at the American Helicopter Society Meeting, Regional District Meeting. April 1966

15. McCourt, Francis P. Ballistic Survey Team Report, SEA. (Classified, title unclassified) Advanced Research Projects Agency, Office of the Secretary of Defense, 1962.

16. McCourt, Francis P. Aviation Crash Injury Research. Presented at the Aviation Crash Injury Steering Committee Meeting, Cornell-Guggenheim Safety Center, December 1961. (Unpublished)

17. McCourt, Francis P. Aviation Crash Injury Research. Presented at the Army Human Engineering Conference, Ft Belvoir, VA. October 1961. (Unpublished)

636

McCOURT, Francis P
8 January 1913

Item 17
Public Speaking

Date	Organization (Professional/Civic)	Function
25 Feb 69	The Sertoma Club, Breakfast Meeting Local Chapter, Newport News, VA	Speaker
30 Oct 68	Annual Meeting, Army Aviation Association of America, Washington, DC	Awardee
15 Oct 68	Local Meeting, Institute of Electrical and Electronics Engineers, Norfolk, VA	Speaker
6 Sep 68	Engineering Management Technology Review Meeting (EMTR) Lockheed Company, Burbank, California	Speaker
June 1968	AIAA 4th Propulsion Joint Specialists Conference	Presented Paper
9 May 68	NASA Research & Technology Advisory Subcommittee on Aircraft Operating Problems	Discussion Leader
19 Mar 68	American Society of Mechanical Engineers Annual Meeting, Washington, DC	Presented Paper
5 Mar 68	Department of the Army Aviation Scientific Advisory Group Meeting, Fort Eustis, VA	Presented Paper
5 Apr 68	Top Management Meeting, Boeing-Vertol Company, Morton, PA	Speaker
4-7 Dec 67	20th Annual International Air Safety Seminar Williamsburg, VA	Presented Paper Panel Member
14-16 Nov 67	American Helicopter Society National Meeting	Panel Member
9 Oct 67	Society of Automotive Engineers Meeting El Segundo, California	Presented Paper
15 Aug 67	Rotary Club, Local Chapter Meeting Newport News, VA	Speaker
26 Jul 67	American Helicopter Society Local Meeting Fort Monroe, Virginia	Panel Member

637

McCOURT, Francis P
8 January 1913

Item 17
Public Speaking (continued)

Date	Organization (Professional/Civic)	Function
8-10 Jun 67	18th National Aircraft Maintenance and Operations Meeting, Reading, Pennsylvania	Presented Paper
26-27 Apr 67	Society of Automotive Engineers Meeting New York, NY	Panel Chairman
10-15 Apr 67	Man/Mobility/Survivability Forum, Allison Division of General Motors, Indianapolis, Indiana	Speaker Panel Member
22-25 Feb 67	Post Crash Fire Meeting, General Dynamics Company, Fort Worth, Texas	Speaker
3-5 Feb 67	Society of Automotive Engineers Meeting San Antonio, Texas	Presented Paper
5-6 Jan 67	Department of Defense Petroleum Committee Washington, DC	Speaker
22-23 Nov 66	Aircraft Fires & Antiaircraft Artillery Threat, North Vietnam Conference (GEN Disosway and Staff), Langley AFB, VA	Speaker
31 Oct - 4 Nov 66	Tactical Air Warfare Center Antiaircraft Artillery Conference, Eglin AFB, Florida	Speaker Panel Member
18-19 Oct 66	5th Aviation Contractors' Safety Representatives' Conference, Norfolk, VA	Speaker
4 - 9 Oct 66	Airline Pilots' Association Air Safety Forum Los Angeles, California (National convention)	Speaker Panel Member
11-13 May 66	American Helicopter Society Meeting Washington, DC	Speaker
24-28 Apr 66	Society of Automotive Engineers National Aeronautic Meeting & Production Forum New York, NY	Panel Chairman
6-9 Oct 64	Annual Mobility Forum, Allison Division of General Motors, Indianapolis, Indiana	Presented Paper Panel Member
19-24 Apr 64	Society of Automotive Engineers Cabin Safety Committee Meeting, Phoenix, AZ	Speaker

McCOURT, Francis P
8 January 1913

Item 17
Public Speaking (continued)

Date	Organization (Professional/Civic)	Function
9-11 Apr 64	Leading Civic & Industrial Personnel Detroit, Michigan	Speaker
3-8 Nov 63	16th Annual International Air Safety Seminar Athens, Greece	Presented Paper Panel Member
2-6 Dec 62	15th Annual International Air Safety Seminar Williamsburg, VA	Presented Paper Panel Member

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK, Plaintiff,	:	
v.	:	AFFIDAVIT
THE NUCLEAR REGULATORY COMMISSION, et al., Defendants.	:	75 Civ. 2121 (WCC)

MONTGOMERY COUNTY)
:
: SS.:
STATE OF MARYLAND)

JOHN W. GOFMAN, being sworn, deposes and says:

1. I am a licensed physician and a nuclear chemist. I am Professor Emeritus of Medical Physics, Division of Medical Physics, University of California at Berkeley, California. I have served as Associate Director of the Lawrence Laboratory (Livermore), in charge of the AEC sponsored program on the biological effects of radiation from radioactivity associated with peaceful and military nuclear energy programs (1963-1969). In that work I did and supervised a large amount of work on the production of cancer by radiation, and was particularly concerned with problems such as cancer production by plutonium. Since that time, in my academic capacity, I have written reports, testified before State Legislature Committees, conducted analytical research, and published some 30 reports and scientific journal papers on the biological effects of radiation.

I was one of the earliest nuclear chemists to work with plutonium, during World War II, and developed two patented processes for the chemical separation and purification of plutonium.

In the field of special nuclear materials, I am additionally qualified, having been co-discoverer both of the existence and fissionability with slow and fast neutrons of Uranium-233, one of the three special nuclear materials of concern here.

By virtue of my education, my directly relevant experience, and the responsibilities that have been assigned to me in directly relevant fields, I am qualified as an expert with respect to the hazardous properties of special nuclear materials, both with respect to their biolcgical effects and their reaching human populations upon dispersal. A summary of my professional qualifications in attached hereto as Exhibit A.

2. I have carefully reviewed the complaint and motion for preliminary injunction and supporting affidavits concerning the alleged risks of air transportation of special nuclear material filed by the plaintiff in this action, particularly those portions pertaining to the hazardous properties of plutonium and the alleged consequences of its dispersal following container failure. I have also carefully reviewed the affidavit of Mr. Robert Barker of the Nuclear Regulatory Commission.

This affidavit and supporting exhibits set forth the basis for my judgment that, in the event of failure of a container of plutonium in an aircraft accident, the risk of dispersal of substantial quantities of plutonium is appreciable. If that happens, the risk that substantial numbers of people would be seriously injured or killed is high. In Exhibit B I have provided my analysis that the lung cancer risk due to plutonium inhalation is so high that even small quantities of plutonium dispersed must be regarded as substantial. Moreover, as is detailed in Exhibit B, the cancer risk estimates made by others previously have been erroneously low because of failure to take into account, properly, the physiology of handling of plutonium particles by the human lung.

In the subsequent paragraphs I shall address, on a point by point basis, my differences with the affidavit of Mr. Robert Barker. I shall further point out that Dr. Resnikoff has underestimated the lung cancer hazard of plutonium.

3. The hazardous properties of the special nuclear material, plutonium, do indeed depend upon the form it is in and the amount (Barker affidavit para 4-6). One form, plutonium oxide, is the choice method for the shipments

of plutonium by air into New York. Unfortunately, this form is also the worst possible form from the point of view of production of human lung cancer upon dispersal. Moreover, it is alleged (Affidavit of Peter N. Skinner, page 5) that the plutonium oxide is in the form of particles of the size range of 1 micron Such particles are right in the middle range of the most serious of all upon dispersal because they do reach the tracheobronchial and pulmonary regions of the lung and provide a dangerous degree of retention in the lung, based upon extensive animal experiments and human accident experience.

4. It is not necessary to discuss the special nuclear material, Uranium-235 at any degree of enrichment, since I do not consider it to present a radiological hazard even if dispersed. For Uranium-233, the hazard, radiologically, is significant, but since I understand this is not contemplated for shipments in the early future, no further discussion will be made of this nuclide. Therefore, in the remaining paragraphs attention will be focussed upon plutonium. Since the biological hazards of plutonium depend upon its alpha particle radiation, the various mixtures of plutonium nuclides can be appropriately handled by measurement in curies (or fractions thereof), since this describes the radiation propertiesin units of radiation independent of the weight mixture of the various plutonium nuclides.

5. In para. 16 of his affidavit, Mr. Barker refers to 30 years of continuing research on plutonium. It is common in scientific history for crucial points to be missed even over longer periods of time. Precisely this has happened (as demonstrated in Exhibit B) concerning the physiological retention of plutonium in the lung. It is my opinion that this has the effect of having led previous scientists to underestimate the toxic, cancer-producing property of plutonium in man by at least 1000-fold. That is, the hazard per unit quantity of plutonium deposited in lung is 1000 times higher than has been previously considered.

6. There is no doubt but that the principal hazard of dispersal of plutonium is via inhalation, rather than via ingestion or via skin applicatio Ingestion does provoke a hazard of producting cancer of the colon. Neverthel under credible circumstances inhalation, with production of fatal human lung cancer, will by far dominate the hazard picture.

7. In para. 21 of his affidavit, Barker states, "The minimum dosage required before there is any chance of significant injury depends upon the type of plutonium inhaled." This statement is misleading. First, it is true that particles sufficiently large, e.g. 20 microns, are highly unlikely to get to the part of the lung where they can produce injury or cancer. But this is also irrelevant here since it is alleged that the shipments by air contain 1 micron particles, which are extremely hazardous. Second, there is no such thing as a minimum dosage required for injury, since all authorities agree that the risk of cancer is in direct proportion to the dose of plutonium inhaled, if it gets to the susceptible lung regions. The expected particles of plutonium oxide do meet this requirement.

8. In para. 22, Mr. Barker indicates that 12 persons having 23 and 24 years exposure time have been kept under surveillance and have shown no evidence of physical changes from their plutonium exposure. This is not a relevant observation with respect to the hazard of plutonium inhalation, which is at issue here. These particular individuals are just now entering the age period in life where lung cancers from plutonium exposure are to be expected. This error has been made repeatedly in the history of radiation injury and cancer, e.g. in the underestimation of cancer from the Hiroshima-Nagasaki bombings and in the similar underestimation of lung cancer in uranium miners on the Colorado Plateau.

There is nothing whatever in the observations on the workers referred to by Mr. Barker that would be at variance with the lung cancer hazards estimated

for plutonium inhalation in Exhibit B, namely, 1 lung cancer for every 0.011 micrograms of reactor plutonium deposited in human lungs of smokers and 0.14 micrograms in non-smokers.

9. In para. 23, Mr. Barker states that "Where inhalation of plutonium is known to have occurred, medical treatment such as lung lavage (flushing with water) and administration of DPTA (diethylene triamine pentaacetic acid) can be used to remove some of the plutonium, and thereby reduce the dose."

This approach cannot possibly be considered relevant in any credible circumstances involving dispersal of plutonium following an aircraft accident. Firstly, the numbers of persons potentially requiring lung lavage could credibly number in the tens or hundreds of thousands, for whom such a procedure is manifestly impractical to consider. Secondly, Mr. Barker appears to have overlooked that DPTA administration was tried in Rocky Flats workers exposed to plutonium oxide in a fire in 1965. There was no reduction in dose from such treatment.

10. In his para. 24, Mr. Barker suggests, "Based upon conservative dose calculations, deposition of 0.01 micrograms of reactor plutonium in the lung might cause death within a 15- to 45-year period after inhalation in about two cases out of 10,000." I consider this calculation to be seriously erroneous. Based upon the material in Exhibit B, I calculate the following:

For cigarette smokers, deposition of 0.01 micrograms of reactor plutonium will cause lung cancer death in 9090 out of 10,000 persons in a 15 to 45 year period.

Therefore, it is my opinion that Mr. Barker has underestimated the seriousness of lung exposure to plutonium by 4045 times for cigarette smokers and by 350 times for non-smokers.

11. In his para. 24, Mr. Barker states that the time required for death decreases as the amount deposited increases. This statement is in error, in

my opinion, and is based upon misinterpretation of experimental animal studies which had too small a number of animals. When this type of experiment was done with a large series of animals by Dr. Miriam Finkel of the Argonne Laboratory, the time to develop fatal cancers did not change with changing the amount of radionuclide deposited.

12. In his para. 24, Mr. Barker states "that the probability of eventual death from this cause is calculated to be about 99% for 260 micrograms." In my opinion, this calculation is grossly erroneous. Based upon the material in Exhibit B, I would calculate the probability of death to be about 99% for 0.011 micrograms in cigarette smokers and for 0.14 micrograms in non-smokers.

13. In his para. 29, Mr. Barker downgrades the hazard of plutonium dispersal in two statements. First, he states that Cohen states that simply blowing air over particles is not an efficient method of dispersing particles. The occurrence of an airplane accident, with attendant fire or explosion or both, hardly qualifies as "blowing air over particles".

Second, Mr. Barker states, "Moreover, the particles tend to stick to things with which they come in contact, for example, grass, buildings or other things." This statement would indicate that one of the key major points has been missed by Mr. Barker. In an air crash with fire and/or explosion, plutonium particles can be immediately airborne, and they will get into the lungs of humans as the plutonium oxide particles fall back to earth wherever they have been blown by the wind. The exposure will have occurred before particles ever had the opportunity to stick to things with which they come in contact.

14. In his para. 36, Mr. Barker refers to approximately 5 tons of plutoni having been dispersed into the atmosphere through weapons testing. And he stat "yet, due to dilution, the amount of plutonium ingested by any one individual is negligible."

Mr. Barker elsewhere in his affidavit demonstrates his realization that inhalation, not ingestion, is the major concern of plutonium dispersal. And

for inhalation, the evidence (Bennett, 1974, and others) is clear and unequivoca. that the amount deposited through inhalation is anything but negligible. Bennet report indicates the average person now carries 52 picograms of plutonium-239 equivalent from the weapons test fallout. My own estimate is that over the entire Northern Hemisphere (where this approximately 5 tons fell out) about 1,000,000 persons have been irreversibly committed to develop fatal lung cancer as a result of this average amount inhaled and deposited.

Further, the consequences to areas of New York of a dispersal of a particular quantity of plutonium are grossly more severe because deposition will occur in 10's and 100's of square miles instead of over the tens of millions of square miles for fallout from the stratospheric dispersal in weapons tests.

Thus, the fallout from dispersal over the tens of millions of square miles of the Northern Hemisphere has already committed serious human harm in fatalities expected from lung cancer. From any particular amount dispersed, the dispersal in an air accident in New York will be approximately 100,000 to 1,000,000 times more serious.

16. In his para. 37, Mr. Barker discusses particle size, and correctly points out that particles above 10 microns will not be inhaled when the nose is exposed. However, it is alleged that some, at least, of the shipments to New York are composed of particles of 1 micron size, which are extremely hazardous for inhalation.

17. In his para. 39, Mr. Barker deals with "Exposure". There he states, "Again it is obvious that if a small amount is dispersed and is widely diffused then the amount any one person can inhale is that much less."

This statement can only reflect that Mr. Barker is unaware of the major principles of cancer induction by radioactive particles. He is correct in saying that any one person gets less. But that is not germane. All authorities in this field would agree with me, I believe, (the BEIR Committee, for example) that if 100 people inhale 1000 particles each, there will be the same number of cancers as if 10,000 people inhale 10 particles each. Thus, wide diffusion

simply means that the same total number of cancers will occur, but over a larger geographic area.

18. In his para. 46, Mr. Barker states that Dr. Resnikoff's predictions of thousands of deaths due to a release of plutonium in an aircraft accident "are based upon certain unrealistic or overly conservative assumptions."

One of the issues Mr. Barker raises is that Dr. Resnikoff has over-estimated radiation dosage. Dr. Reznikoff did not have the benefit of the new information to be found in Exhibit B. That information should have led Dr. Resnikoff to predict dosages 103 times higher to the cancer-relevant lung bronchus cells, at least for the approximately 50% of the population smoking cigarettes. Thus, on <u>biological</u> grounds Dr. Resnikoff's predictions of dosage are far too low, not too high. Even if he were too high on meteorological considerations, it is difficult, at best, to see how this factor of 103 could have been overcome. My opinion, therefore, is that Dr. Resnikoff was not conservative enough, which is the direct opposite of Mr. Barker's suggestion of "overly conservative assumptions".

19. In his para. 55 on Dose Conversion Factors, Mr. Barker speaks about studies from E.R.D.A. and from Oak Ridge having used a 50-to 70-year period for dose delivery after intake of plutonium. Then he goes on to state, "The individual dose during the first month following exposure is about twenty times lower."

One must wonder what conceivable relevance Mr. Barker attaches to the dose in the first month following exposure. Certainly no expert in radiation injury would attach the least significance to this first month dose. The reason is that the relevant dose for cancer production is the <u>cumulative</u> dose; by no means, the first month dose. Further, all experts on plutonium know that the clearance from the lungs is very slow, only about ½ being removed from lungs in a year and a half. It is absolutely essential, therefore, to cumulate dosages over far, far more than one month to make any meaningful assessment of cancer-production risk in the exposed individual.

20. In his para. 54, Mr. Barker refers to Dr. Resnikoff's treatment of the exposure of airport personnel. Dr. Resnikoff estimated in his affidavi Appendix B, Table 4, that 30,000 persons at the airport are expected to die of lung cancer in his case B. Mr. Barker criticized Dr. Resnikoff as follows: "Dr. Resnikoff further assumed that all persons at the airport (30,000) would receive exposure at the maximum level." Mr. Barker then states that his own analysis shows, "Thus the effects of the plutonium on the airport personnel estimated by Dr. Resnikoff are about 5 to 10 times higher than they actually would be."

We can, for analysis, assume Mr. Barker's meteorological estimate might be correct. But even if it is, he states this lowers the dose by a factor of 5 or 10. From the information in Appendix B of this affidavit and from para 18 (this affidavit) we must estimate that Dr. Resnikoff's dose evaluation was too low by a factor of 103 times for cigarette smokers exposed to plutonium, and by a factor of 8.2 times for non-smokers. Therefore, even if Mr. Barker's meteorology factors of 5 to 10 were correct, these dosage factors would still greatly overwhelm the reduction. Hence, if Dr. Resnikoff estimated that all 30,000 at the airport would die, incorporation of Barker's factors and mine still would lead to the conclusion that all 30,000 would die.

21. On page 9 of Dr. Resnikoff's affidavit, he discusses his Case A involving New York City. He calculates that each of the 8,000,000 persons would inhale 6.8×10^{-6} Ci. To convert from inhaled plutonium to deposited plutonium, it is necessary to divide by 4, so the lung deposited plutonium per person would be 1.7×10^{-6} Ci, or 1.7 microcuries. For reactor-plutonium, 1 microcurie is 3.0 micrograms. Therefore, each person gets 5.1 micrograms.

For cigarette smokers, the lung cancer dose (see definition in Appendix B) for reactor-plutonium is 0.011 micrograms, so each person will receive 5.1/0.011, or 464 lung cancer doses. This is 464 times as much as required for <u>all</u> the exposed subjects to be assured of lung cancer death.

For non-smokers, the lung cancer dose is 0.14 micrograms of reactor-plutonium. Therefore, each person would receive 5.1/0.14, or 36.4 lung cancer doses. All these people would also be guaranteed lung cancer death.

The only mitigating factor is that persons older than 30 years of age may be 10-fold less sensitive than 20-30 year olds. But since the number of lung cancer doses is so high, this will not prevent deaths even in the older persons exposed.

My conclusion is that all 8,000,000 people in New York City will die of lung cancer (unless, of course, they die before their cancer develops) instead of Dr. Resnikoff's estimate of 105,000 deaths.

For his case B, Dr. Resnikoff estimates (his Table 4) that the Ci uptake (beyond the airport) is 3.06×10^{-6} Ci per person even for those exposed the least, namely, at 100 km. Dividing by 4 to convert inhaled to deposited plutonium, we get 0.76×10^{-6} Ci or 0.76 microcuries. Converting to micrograms, we get 2.28 micrograms reactor-plutonium per person.

My conclusion, since these doses are far more than one lung cancer dose per person, is that all 2,650,000 exposed persons in Dr. Resnikoff's Case B will die of lung cancer, instead of Dr. Resnikoff's estimate of 46,700 cancer deaths beyond the airport.

In Dr. Resnikoff's Case C (Table 5, his affidavit), for persons beyond the airport, he estimates a total uptake of 0.521 Ci. Dividing by 4 to convert inhaled to deposited plutonium, we get 0.13 Ci total deposited in some 12.4 million persons.

As a first approximation, we shall assume half the dose goes to smokers, and half to non-smokers. Therefore, each group gets 0.065 Ci. Conversion to microcuries gives 6.5×10^4 microcuries. Conversion to micrograms gives 19.5×10^4 micrograms.

For smokers, therefore, lung cancer doses $= \frac{19.5 \times 10^4}{0.011} = 1.77 \times 10^7$ lung cancer doses.

For non-smokers, lung cancer doses $= \frac{19.5 \times 10^4}{0.14} = 1.39 \times 10^6$ lung cancer doses.

Therefore, for the 6.2 million smokers, it is predicted that essentially all will die of lung cancer, since there are approximately 3 lung cancer doses per person. Even for the group farthest out (100K m), each person averages more than 1 lung cancer dose.

For the 6.2 million non-smokers, approximately one out of five will die of lung cancer, or about 1.2 million.

Total deaths predicted are approximately 7.4 million persons instead of 1011 deaths predicted by Dr. Resnikoff.

23. In para. 52 of his affidavit, Mr. Barker criticizes Dr. Resnikoff's predictions for Manhattan on the ground, "The wind blows in a northwesterly direction toward Manhattan on the average only about 3% of the time."

Considering that my own analysis is that in this case essentially all 8 million persons in Manhattan would die of lung cancer, it is hardly reassuring that this might happen on 1/30 of the potential days for an aircraft accident. Considering the consequences, it would be reasonable to require that such winds must occur less than once in a billion days, rather than once in 30 days. So Mr. Barker falls far far short of meaningful reassurance.

24. In Dr. Resnikoff's affidavit (page 11) he states, "I have included no effects due to resuspension of the Pu dust, which may be the most serious of all possibilities."

I express my total agreement that this may indeed be the most serious of all possibilities. It is so serious that, even for a dispersal of 1/100 as much plutonium as Dr. Resnikoff's analysis describes, I would consider that evacuation of New York City would require serious contemplation. The economics

and social implications of this for the people of New York, for the economy of New York, and for the economy of the country would represent a peacetime disaster unparalleled in the history of the USA.

To be sure, the resuspension could be mitigated to some degree by washdowns of buildings and streets, but one could hardly anticipate total effectiveness of this. Anything short of total effectiveness would fail to prevent the total panic and paralysis of New York City.

25. Conclusion

In making this affidavit I support the motion of plaintiff for a preliminary injunction. I do so because I consider, after careful review, that a serious immediate hazard exists if air shipments of plutonium continue. I find that Dr. Resnikoff's estimate of the hazard, in itself very serious, is a major underestimate of the hazard. I find, further, no significant answer, (as pointed out in all parts of this affidavit) to the seriousness of the hazard in the affidavit provided by Mr. Barker of the Nuclear Regulatory Commission.

John W. Gofman
JOHN W. GOFMAN

Sworn to before me this
10 day of June, 1975

Louie Bertolucci
Notary Public

OFFICIAL SEAL
LOUIE BERTOLUCCI
NOTARY PUBLIC - CALIFORNIA
SAN FRANCISCO COUNTY
My comm. expires APR 27, 1979

401 Judah St., San Francisco, CA 94122

651

EXHIBIT A

Educational and Professional Qualifications

of John W. Gofman

Birth: Cleveland, Ohio, September 21, 1918

Education: A.B. Chemistry, Oberlin College, 1939
Ph.D. Nuclear Chemistry, University of California, Berkeley, California, 1943
M.D. School of Medicine, University of California, San Francisco, California, 1946
Internship, Dept. of Medicine, University of California, San Francisco, California, 1946-47

Experience and Responsibilities:

1. Academic Appointment to Division of Medical Physics, University of California, Berkeley, California as Asst. Professor, 1947.
2. Advanced to Full Professorship, 1954 and held that position until voluntary acceptance of Emeritus Status, January 1974.
3. Member and Research Associate, Lawrence Laboratory (Berkeley and Livermore), 1947-1973.
4. Appointed to organize Biomedical Division (auspices of US AEC) at Lawrence Livermore Laboratory, 1963. Served as Chairman of Biomedical Division, 1963-1965.
5. Associate Director (for Biology and Medicine) of the Lawrence Livermore Laboratory, 1963-1969.
6. Member of the National Nerva Advisory Board on Space Nuclear Propulsion (approx. dates 1963-1966).
7. Physician in Charge (Industrial Medicine and Radiation Protection) Lawrence Livermore Laboratory, 1953-1957.
8. Consultant in Radiation Protection and Industrial Medicine, Aerojet General Nuclear Corporation, 1960-1967 (approx. dates).
9. Group Leader, Plutonium Project, University of California, Berkeley, California, 1942-1944. (part of The Manhattan Project).

Patents:

1. The Columbium Oxide Process for Separation of Plutonium.
2. The Sodium Uranyl Acetate Process for Separation of Plutonium.
3. The Production and Fissionability of Uranium-233.

Scientific Publications in Relevant Area:

1. A Series of 24 Reports on the Cancer and Genetic Hazaad of Ionizing Radiation (Reports GT 101-124, Lawrence Livermore Laboratory. Also published in Hearings of the Joint Committee on Atomic Energy, 91st Congress. Hearings of January 28, 1970. (with A.R.Tamplin).
2. Gofman, J.W. and Tamplin, A.R. "Epidemiologic Studies of Carcinogenesis by Ionizing Radiation", in Proceedings of the Sixth Berkeley Symposium on Mathematical Statistics and Probability", Statistical Laboratory, University of California, U.C. Press, Berkeley, California 94720.
3. Co-Editor of "Advances in Biological and Medical Physics". A 13-Volume Series, Academic Press, New York.

652

Teaching: (as Professor) 27 years at University of California, Division of Medical Physics at Berkeley, including Biological Effects of Radiation, Radionuclides in Biology and Medicine, Carcinogenesis, general, and Radiation-Carcinogenesis.

John W. Gofman
1045 Clayton Street
San Francisco, California 94117

EXHIBIT B.

THE CANCER HAZARD FROM INHALED PLUTONIUM

John W. Gofman

May 14, 1975

CNR Report 1975-1

COMMITTEE FOR NUCLEAR RESPONSIBILITY
P.O. Box 2329
Dublin, California 94566

Foreword

The calculations presented here, and in the other reports of this CNR series, represent a first approximation of the biological hazards from plutonium exposure.

In essence, these are studies of the dosimetry of plutonium exposure. There are certain critical voids in mankind's knowledge of the physical and physiological parameters which determine the dosimetry, and thus we have made necessary assumptions which are all clearly identified.

It is anticipated that as additional data become available, the calculations herein will be updated to take them into account.

Summary of Conclusions

(1) The lung cancer potential in humans from inhaled insoluble compounds of plutonium (such as PuO_2 particles) has been grossly underestimated by such authoritative bodies as the International Commission on Radiological Protection and the British Medical Research Council.

(2) The term "lung cancer dose", used freely in this report, has a specific scientific definition, namely, the reciprocal of the lifetime lung cancer risk per unit of radiation, whatever be the units under discussion. In more popular terms, one "lung cancer dose" of a carcinogen such as plutonium introduced into a population will assure one extra lung cancer death.

(3) The lung cancer hazard of plutonium inhalation is much higher for cigarette-smoking humans than for non-smokers. The calculations presented here suggest the following values for inhalation of insoluble plutonium particulates.

For Cigarette-Smokers:

Pu^{239}

(a) 0.058 micrograms deposited Pu^{239} represents one "lung cancer dose".

(b) 7,830,000,000 "lung cancer doses" per pound of Pu^{239}.

Reactor-Pu

(a) 0.011 micrograms deposited reactor-Pu represents one "lung cancer dose"

(b) 42,300,000,000 "lung cancer doses" per pound of reactor-Pu.

For Non-Smokers:

Pu^{239}

(a) 0.73 micrograms deposited Pu^{239} represents one "lung cancer dose".

(b) 626,000,000 "lung cancer doses" per pound Pu^{239}.

Reactor-Pu

(a) 0.14 micrograms deposited reactor-Pu represents one "lung cancer dose".

(b) 3,380,000,000 "lung cancer doses" per pound of reactor-Pu.

(4) While the estimated hazard is some twelve times lower for non-smokers than for smokers, the hazard for non-smokers for reactor-Pu, which is what nuclear energy provides, is indeed severe. Clearly, there would be no source of comfort available even if no one in the population smoked cigarettes.

(5) The reason for the gross underestimate by ICRP or BMRC is their use of a totally unrealistic, "idealized" model for the clearance of deposited plutonium from the lungs and bronchi, plus their non-recognition of the bronchi as the true site for most human lung cancers. The erroneous model used by such organizations fails totally to take into account the effect of cigarette-smoking upon the physiological function of human lungs.

(6) Plutonium nuclides, or other alpha particle-emitting nuclides, in an insoluble form, represent an inhalation hazard in a class some five orders of magnitude more potent, weight for weight, than the potent chemical carcinogens.

(7) The beagle dog data on lung cancer production from inhaled plutonium already are in good general accord with the human estimates of this report, even though it is widely realized that the current beagle data must be overestimating the lung cancer dose. When the beagle data became available at lower dosages, it is virtually certain that they will not be an order of magnitude away from the human estimates.

(8) None of the calculations presented in this report make any use of "hot particle" theories and are in no way dependent upon such theories. Unfortunately, so much effort has been expended, for example, by the British Medical Research Council, in countering "hot particle" theories that they overlooked the real cancer hazard derivable from straightforward dosimetry, as presented here. It turns out that dosimetry provides cancer risk estimates well within order of magnitude agreement with those predicted by Geesaman-Tamplin-Cochran.

(9) The lung cancer potential of insoluble particles of plutonium compounds should result in worldwide rejection of nuclear fission energy involving any kind of plutonium handling or recycling. No meaningful mitigation of this problem would be achieved even if cigarette smoking stopped totally.

THE CANCER HAZARD FROM INHALED PLUTONIUM

John W. Gofman*

Introduction

At this critical juncture for societal choices of energy supply for the future, one possible choice is a nuclear fission economy based upon the element plutonium (element 94). Tamplin and Cochran [1] have pointed out that the U.S. AEC projected that over 4 million megawatts of nuclear capacity will be installed between 1970 and 2020. Based upon this estimate, Tamplin and Cochran pointed out that over the lifetime of these plants this installed capacity could result in a cumulative flow of approximately 200 million kilograms (440 million pounds) of plutonium through the nuclear fuel cycle. Putting this much plutonium "through the nuclear fuel cycle" means plutonium becomes a commonplace article of commerce, being handled by thousands of workers and being transported on highways, railways, and airways in numerous shipments per day.

Plutonium is widely recognized as a potent carcinogen, and is of particular concern in the form of insoluble particles of plutonium dioxide (PuO_2) as a very potent agent for the production of lung cancer in man. Estimates have been made by several individuals and groups of the number of human lung cancers to be expected for the inhalation of specified quantities of PuO_2 particles. Such estimates range over several orders of magnitude, with Cohen [2] providing the lowest estimate, Tamplin-Cochran [1] providing the highest estimate, and the British Medical Research Council [3] providing evidence suggesting an intermediate value. Unfortunately, the problem has been clouded by needless polemic discussion of whether or not the "hot particle" hypothesis (Geesaman) [4]

*John W. Gofman, M.D., Ph.D. is Professor Emeritus of Medical Physics, Division of Medical Physics, University of California, Berkeley, California.

is correct. The issue of PuO_2 particle carcinogenicity can be approached in a straightforward manner with no reference whatever to "hot particle" theories.

It is our purpose here to present such a straightforward analysis leading to some reasonable limits for the expected numbers of human lung cancers for the inhalation of plutonium particulates. There are certain crucial voids in our knowledge of the behavior and disposition of PuO_2, once deposited in the lung. As a result, the estimate of the number of cancers becomes dependent upon the assumptions used where evidence is lacking. Cohen, in his analysis, simply overlooked the important problems of behavior of the PuO_2 in the lung. The British Medical Research Council paid lip service to certain of the problems, but then neglected to indicate how failure to address the problems might provide a falsely low estimate of lung cancer hazard from plutonium inhalation.

Detailed Analysis of Lung Cancer Induction by Plutonium

The analysis of the lung cancer-producing properties of inhaled plutonium particulates (usually, but by no means necessarily, insoluble particles of PuO_2) proceeds by several steps.

Step 1: Analysis based upon the known carcinogenicity of x-rays, gamma rays, and neutrons for human lung tissue, followed by analysis of the dose to be delivered to lung tissue by inhaled particulates of plutonium, assuming the plutonium delivers its radiation to the entire mass of broncho-pulmonary tissue. Since the nuclear power industry will provide mixtures of plutonium nuclides, rather than the predominant nuclide, Pu^{239}, the analysis will consider effects of Pu^{239} and effects of Pu mixtures from nuclear power reactors, to be designated simply as "reactor-Pu".

Step 2: Analysis of the nature of the problem of non-uniform distribution of plutonium within the lung and the crucial problem of which cells in the broncho-pulmonary system are involved in human lung cancer production.

Step 3: Final estimates of the probable limits to be placed upon the lung cancer expectations per pound of plutonium deposited in lung tissue of human populations.

Step 1. Analysis based upon the known carcinogenicity of x-rays, gamma rays and neutrons for human lung tissue.

There has been, for several years, conclusive evidence that human population groups exposed to x-rays, or to combinations of x-rays, gamma rays, and neutrons have developed an excess of lung cancers that must be attributed to radiation exposure. Gofman and Tamplin[5-23] have presented comprehensive analysis of the quantitative aspects of such lung cancer production. More recently the BEIR Committee presented its analysis of the same evidence.[24] We shall discuss the differences (minor, at best) in the conclusions to be derived from both analyses. There is abundant additional proof that broncho-pulmonary irradiation produces lung cancer in man from the tragic experience of uranium (and other) miners exposed to radon gas and daughter products of radon. However, we shall refrain from using these latter data for quantitative purposes because virtually everyone realizes that dose estimation in rads or rems is exceedingly tenuous at best for the miners.

The analysis of Gofman-Tamplin led to the conclusion that, for diffuse lung irradiation, there occurs a 2% increase over the spontaneous lung cancer death rate each year in an exposed population, once the latent period of some 10-15 years is passed.[25] Precisely how long this 2% per year increase (in lung cancer death rate) persists is not known from direct evidence. A modestly conservative estimate (agreed to by many observers) is a persistence of 30 years, but persistence for the remainder of the life span of the exposed population cannot be ruled out. The BEIR Committee recognized this uncertainty in its report. The value of 2% increase over spontaneous lung cancer death rate, according to Gofman-Tamplin, applies for young adults of the 20-30 year age range.

Some workers have analyzed lung (and other cancer) production by radiation in terms of the absolute number of cancers produced per rem exposure of a population, with no reference to a percent increase over the spontaneous occurrence rate. Cohen has chosen this approach, with the strange statement that:

> "It may be noted that our calculations employed the "absolute risk" model of Reference 5 (the BEIR report) rather than the "relative risk" model. Primarily this is because the age-dependent risk of each type of cancer is not readily available, and the calculations are more complex. In ref. 5, the relative risk model gives a two times larger effect. However, the available evidence tends to support the absolute risk model and it seems to be preferred by most experts in the field, so its use is justified by our aim to determine the most probable effects."

The available evidence, in the opinion of the present author, is very much in favor of the opposite conclusion - namely, that the relative risk method has very sound foundation indeed. A variety of pertinent sources of evidence points strongly to radiation action as a multiplier of other carcinogenic influences (e.g., radiation multiplies the effect of cigarette smoking in the uranium miners). If radiation acts as a multiplier, then the best approach is the relative risk method, with a specified percent increase over the spontaneous cancer fatality rate per rem of exposure. The BEIR Committee was unable to choose between the two approaches, commenting as follows: (p.99, BEIR Report)

> "Absolute risk estimates are generally more useful for purposes of radiation protection than are relative risk estimates, because they specify directly the number of persons affected. On the other hand, if the risk due to radiation were found to increase in proportion to the natural risk, then the relative risk would provide the more appropriate estimate. Since the existing knowledge of radiation carcinogenesis is not always sufficient to indicate which type of estimate applies best in a given situation, both the absolute risk (where possible) and the relative risk are given in this report."

Since the present author considers the scientific evidence overwhelmingly in favor of the relative risk method, that method (including BEIR's relative risk estimates)

will be used in all calculations here. It is a very simple matter, as will be noted, to convert the relative risk estimates, scientifically sound, into absolute numbers of lung cancer fatalities. Moreover, in periods of rapidly changing lung cancer death rates (such as the 1940-1975 period in the USA), the relative risk method can avoid serious errors of under-estimation. The absolute risk method, using data for populations exposed in or before 1945, may be truly irrelevant in making estimates for the real world of 1975.

The most recent datum from the American Cancer Society provides the estimated value, 63,500 lung cancer deaths per year (1975) for men in the USA.[26] Virtually all these lung cancer deaths are in men over 25 years of age, so they may be taken to occur in a population of approximately 50 million men (those over 25 years of age).

The spontaneous (or as BEIR calls it, the "natural") lung cancer death rate, therefore, is

$\frac{63500}{5\times10^7}$, or 1.27×10^{-3}/year. Expressed otherwise, this means 1.27 fatal lung cancers per 1000 persons per year, spontaneously occurring in men over 25 years of age.

If we now utilize the Gofman-Tamplin figure above of a 2% increase over the spontaneous rate per rem of exposure, we arrive, per rem, at the following:

$(0.02)\ (1.27\times10^{-3})$, or 2.54×10^{-5}/year as the expected increase in lung cancer fatalities per year per rem of exposure. Henceforth in this discussion, we shall refer to estimates arrived at in this manner as "Gofman-Tamplin" estimates.

The BEIR Committee arrived at a somewhat lower percentage increase per rem of exposure. However, BEIR realized that the exposed subjects had not been followed long enough to be sure they were on the "plateau" of observed effects. We may quote BEIR Report (p. 156) as follows:

> "It is possible, therefore, that in the final analysis the absolute risk in these groups will approach $2/10^6$/year/rem and the relative risk will reach 0.5% or higher. For the three groups (miners and Japanese

survivors) in which up-to-date information is available, it is significant that many new cases have been added during the past few years."

This is a powerful admission by the BEIR Committee. They are admitting that their estimate is only four-fold lower than Gofman-Tamplin and admitting that when all the evidence is in, they may be even closer to Gofman-Tamplin estimates.

Let us not anticipate the future, and simply proceed utilizing the BEIR figure of 0.5% increase in relative risk per year per rem, realizing that it is not a most conservative public health estimate. *

Since 0.5% is 1/4 of 2%, we would say that BEIR should conclude that the risk of fatal lung cancer, for USA subjects in 1975, is

1/4x2.54x10^{-5}/year/rem, or 6.3x10^{-6}/year/rem.

Henceforth in this discussion, we shall refer to estimates based upon this number as "BEIR" estimates.

Cohen, in his analysis, quotes BEIR as giving "The cancer risk of radiation to the lung as 1.3x10^{-6}/year-rem for adults". This low figure, based upon absolute data from 1945, may be truly irrelevant for exposure of populations today.

Henceforth in this discussion, we shall refer to Cohen's analysis based upon the 1.3x10^{-6} lung cancer deaths/year-rem as the "Cohen" estimate.

It was stated above that most observers (including BEIR Committee) consider the "plateau" effect may persist for 30 years, or even longer. And while not truly conservative (in the absence of positive knowledge), we shall, for present purposes, utilize the potential underestimate of 30 years on the "plateau".

This leads to the following total lung cancer production per rem as follows:

"Gofman-Tamplin" 30 x 2.54x10^{-5} = 7.62x10^{-4} lung cancer deaths per lifetime-man-rem.

"BEIR" 30 x 6.3x10^{-6} = 1.89x10^{-4} lung cancer deaths per lifetime-man-rem.

"Cohen" 30 x 1.3x10^{-6} = 3.9x10^{-5} lung cancer deaths per lifetime-man-rem.

*See Note 1 in "Supplemental Notes".

The Concept of the "Lung Cancer Dose"

It has become commonplace recently to alter such presentations of risk into another format, namely, that which describes "the lung cancer dose". This is a simple and useful way to present the estimates. If the lifetime risk is x per man-rem, then the "lung cancer dose" is (1/x) man-rems.

Thus, for illustration, if the lifetime risk is 1 out of 10, which means 0.1 per man-rem, then the "lung cancer dose" is 1/0.1, or 10 man-rem.

Applying this relationship to the estimates above, we derive the following:

	"Lung Cancer Dose", in man-rem
"Gofman-Tamplin"	$\frac{1}{7.62 \times 10^{-4}}$, or 1310 man-rem.
"BEIR"	$\frac{1}{1.89 \times 10^{-4}}$, or 5290 man-rem.
"Cohen"	$\frac{1}{3.9 \times 10^{-5}}$, or 25,600 man-rem.

Calculation (Step 1 level) of "Lung Cancer Dose" for Insoluble Inhaled Plutonium Particles

The Cohen approach (which we shall here term Step 1 level calculations) is to calculate plutonium dosage as though the dose were distributed throughout the entire mass of lung tissue. While it will be shown below (Step 2 calculation) wi[illegible] is not reasonable, it will suffice for Step 1 calculations. Cohen has used the re[illegible] value of 570 grams as the lung mass for average man (exclusive of blood). Further, Cohen has applied a factor of 10 for conversion of rad to rem for the alpha-particle radiation of plutonium. The British Medical Research Council Report suggests (p. 10) a valu[illegible] of 10-20 for this conversion. Again, even though possibly not conservative enough, we shall use the Cohen value of 10 for conversion of rads to rems.

To convert microcuries of plutonium deposited to dose in rems, Cohen has used the equation:

Dose in rems/day = 51 EQ/M rems/day-microcurie

where E = energy deposited by alpha radiation in MEV

M = mass of organ in grams

Q = quality factor (the ratio of rems to rads, or the ratio of carcinogenic damage of the Pu alpha particles to that of gamma rays of the same energy).

(E for Pu^{239} = 5.1 MEV; Q = 10; M = 570 grams)

We shall accept all this for Step 1 calculation purposes, except to re-iterate that using M = 570 grams assumes distribution of the dose to the whole lung tissue mass. In Step 2 calculations below, this crucial issue will be treated in detail.

Using the equation above, Cohen arrives at 2000 rems (for that portion of the plutonium presumed to be retained in the lung with a 500 day half-time for removal) per microcurie of deposited plutonium (Pu^{239}). We shall return later to this "500 day half-time for removal", but for Step 1 calculation, the 2000 rems per microcurie will be accepted. Incidentally, since the other Pu nuclides in "reactor-Pu" will have E values not very different from the 5.1 MEV for Pu^{239}, the same calculation will apply per microcurie of other Pu nuclides.

Since we have, above, assigned for the "Cohen" estimate, a value of 25,600 man-rem as the "lung cancer dose", it follows that 1 microcurie of Pu^{239} delivers $\frac{2000}{25600}$, or 0.08 "lung cancer doses".

Expressed otherwise, 1/0.08, or 12.5 microcuries Pu^{239} (For "Cohen" estimates) deposited provide one "lung cancer dose".

In Cohen's paper, he used a risk of "about 4.7 percent" per microcurie instead 8% per microcurie by including the risk for children (erroneously, we believe) and the

risk for adults well beyond 30 years of age. Since we are comparing all estimates for adults 20-30 years of age, we have made the minor adjustment in Cohen's estimate back to 8% per microcurie (as per his Figure 2).

Cohen stated, additionally, that of all the plutonium particulates inhaled, only 25% is retained for potential deposition, and he therefore multiplies his "lung cancer dose" by a factor of 4. Since all these discussions relate to deposited plutonium, rather than inhaled plutonium, it is inappropriate to utilize this particular factor of 4. Thus, we shall leave the "Cohen" estimate at 12.5 microcuries deposited Pu^{239} per "lung cancer dose" or per "lung cancer death".

There are 16.3 micrograms of Pu^{239} required to provide 1 microcurie of Pu^{239} alpha radiation. (This is directly calculable from the 24,000 year half-life of Pu^{239}).

Therefore, the "Cohen" estimate becomes

(12.5)(16.3), or 204 micrograms of Pu^{239} deposited per "lung cancer dose".

For "BEIR" estimate, with 5290 man-rems per "lung cancer dose", we calculate

$\frac{5290}{2000}$, or 2.65 microcuries Pu^{239} per "lung cancer dose".

Converting to micrograms, 2.65x16.3 = 43.2 micrograms Pu^{239} deposited per "lung cancer dose".

For "Gofman-Tamplin" estimate, with 1310 man-rems per "lung cancer dose", we calculate $\frac{1310}{2000}$, or 0.66 microcuries Pu^{239} deposited per "lung cancer dose".

Converting to micrograms, (0.66x16.3) = 10.8 micrograms Pu^{239} deposited per "lung cancer dose".

All these data are summarized in Table 1.

Table 1

Step 1 Calculation

(assuming distribution of plutonium-239 throughout entire lung mass)

Estimate	Man-Rem per "Lung Cancer Dose"	Micrograms Pu^{239} deposited per "Lung Cancer Dose"
"Gofman-Tamplin"	1,310	10.8
"BEIR"	5,290	43.2
"Cohen"	25,600	204

Cohen has pointed out, correctly, that the mixture of plutonium nuclides from power reactors contains, in addition to Pu^{239}, several shorter-lived nuclides. Therefore, he states, correctly, that reactor-grade Pu is some 5.4 times as hazardous by weight as pure Pu^{239} (as high as 10 times in high burn-up light water-reactor fuel). Taking this 5.4-fold hazard factor into account, we arrive at the estimates in Table 2.

Table 2

Step 1 Calculation

(assuming "reactor-F[illegible]" distributed throughout entire lung mass)

Estimate	Micrograms Reactor Grade Pu per "Lung Cancer Dose"
"Gofman-Tamplin"	2.0
"BEIR"	8.0
"Cohen"	37.8

We are now in a position to make a Step 1 estimate of the "lung cancer doses" per pound of Pu^{239} or per pound of reactor-grade Pu. The reader may well ask "Why calculate per pound of plutonium?" The answer is simply this. For considerations of the hazard posed by a plutonium-based nuclear fission energy economy, we know the number of pounds expected to be in daily commerce, and thus it is well to know the number of "lung cancer doses" involved in such an economy.*

*See Note 2 in "Supplemental Notes"

The calculation itself simply involves the number of micrograms per pound and the number of micrograms per "lung cancer dose".

1 pound = 454 grams

or, 1 pound = $4.54 \times 10^2 \times 10^6 = 4.54 \times 10^8$ micrograms.

Illustratively, we may calculate the number of "lung cancer doses" per pound of Pu^{239} in the form of insoluble PuO_2 particles or other finely dispersed insoluble Pu compounds.

From Table 1, for "Gofman-Tamplin" estimates, we have 10.8 micrograms Pu^{239} deposited per "lung cancer dose".

Therefore, "Lung Cancer Doses" per pound of $Pu^{239} = \frac{4.54 \times 10^8}{10.8}$, or 42,000,000 "lung cancer doses".

Similar calculations, for all three estimates, both for Pu^{239} and "reactor-Pu" are presented in Table 3.

Table 3

Step 1 Calculation

"Lung Cancer Doses" per pound of Plutonium

Estimate	"Lung Cancer Doses" per pound Pu^{239}	"Lung Cancer Doses" per pound Reactor-Pu
"Gofman-Tamplin"	42,000,000	227,000,000
"BEIR"	10,500,000	56,800,000
"Cohen"	2,225,000	12,000,000

It must be re-iterated here that all calculations of Step 1 type assume that the plutonium is distributed throughout the entire lung tissue mass. It does not assume uniformity of dose, but rather that the entire lung mass is the distribution region for the plutonium. As will be shown in Step 2 below, this may mean that the estimates of Table 3

represent minimum, rather than probable, estimates of the "lung cancer doses" per pound of plutonium.

Step 2: Analysis of the Nature of the Problem of Non-Uniform Distribution of Plutonium Within the Lung and the Crucial Problem of Which Cells in the Broncho-pulmonary System are Involved in Human Lung Cancer Production.

When a population is irradiated by x-rays, gamma-rays, or neutrons, and a dose is properly estimated for lung, we can expect, correctly, that the dose in rems to all segments of the lung-bronchus system is, to a good first approximation, everywhere identical. Under these circumstances it is reasonable to state that 570 grams of lung tissue have been irradiated. Even if some of the tissue (e.g. cartilage, smooth muscle, fibro-elastic support tissue) is not at all involved in cancer production, the dose estimate to the critical tissue susceptible to cancer production is still correct.

For inhaled particulate matter, estimation of the radiation dose as though the particles are distributed into 570 grams of lung tissue can be totally absurd. For example, it is extremely unlikely that any significant part of the inhaled particulates lodges in such tissues as bronchial cartilage, bronchial smooth muscle, walls of pulmonary arterio-venous network, or in fibro-elastic tissue. Therefore, the deposited particulates are distributed into some mass of tissue (including the critical cells for development of lung cancer) much less than 570 grams in mass. How much less? A reasonable first approximation, eliminating cartilage, fibro-elastic support tissue, arterial and venous walls, smooth muscles, and nerves, is that the relevant mass of tissue for distribution of the inhaled plutonium particulates cannot be more than 1/2 of 570 grams. Though this is just a beginning of Step 2 considerations, it immediately permits revision of Table 3 estimates upward by a factor of two. The revised results are presented in Table 4.

Table 4

(Preliminary Step 2 Calculation, based upon 0.5x570, or 285 grams as the Lung Tissue Mass)

"Lung Cancer Doses" per pound of Plutonium

Estimate	"Lung Cancer Doses" per pound Pu^{239}	"Lung Cancer Doses" per pound Reactor-Pu
"Gofman-Tamplin"	84,000,000	454,000,000
"BEIR"	21,000,000	113,600,000
"Cohen"	4,450,000	24,000,000

The Relevant Tissue for Lung Cancer Production

It is well known that the large preponderance of "lung" cancers arise in the bronchi rather than in the parenchymal lung tissue. Indeed it is this preponderance that accounts for lung cancer generally being referred to as bronchiogenic cancer. The BEIR report recognizes this, as does the British Medical Research Council Report. McCallum (27) states that such cancers are rare in the trachea or the two main-stem bronchi. The cancers are also relatively rare in the bronchioles. So the crucial tissue at risk must be the segmental bronchi, and, within these, the epithelial layer of the bronchi. What is really required is an estimate of the dose delivered by insoluble plutonium particles to this critical tissue, where almost all of the bronchiogenic cancers arise. The British Medical Research Council Report recognized this requirement, but in an apparent zeal for a pejorative analysis of the Geesaman-Tamplin-Cochran "hot particle" thesis, the B.M.R.C. report simply failed to address the most crucial problem of all.

The very fate of human societies may well rest upon this issue, considering the the proposed handling of some 440 million pounds of plutonium (and reactor-grade at that) in the next 50 years in a plutonium-based nuclear fission energy economy.

It is strange indeed that virtually all workers (Cohen, British Medical Research Council, ICRP, and others) have seemed fascinated by the 25% of inhaled plutonium deposited in the tissues beyond the bronchi, when virtually all the cancers arise in the bronchi. It almost seems as though the prevailing mood is that if a serious problem is simply neglected, it may disappear.

The Dose to Relevant Tissue

As will become evident below, it is no simple matter, in the current state of our ignorance, to calculate the true dose from insoluble PuO_2 particles to the relevant bronchial tissue.

All the above-mentioned groups or individuals have made use of a model for lung dynamics developed by a Task Group of the ICRP.[28] This model may be totally irrelevant for the question of exposure of the relevant bronchial cells. What does this model suggest, and where may it fail seriously in the real-life situation?

The model suggests that when PuO_2 particles are inhaled that some 8% deposits in the "tracheo-bronchial" region and some 25% deposits in the deep respiratory tissue ("pulmonary tissue"). It further assumes that the PuO_2 deposited in the tracheo-bronchial region is rapidly cleared into the intestine via the naso-pharynx, with 99% being cleared in less than a day. For the "pulmonary tissue" (tissue beyond the terminal bronchioles), the model suggests that 40% of the deposited PuO_2 is cleared in a day and 40% is cleared with a half-time of some 500 days. The remaining 20% is presumed, in the model, to be cleared via lymph and blood. The 80% (including the 40% rapidly cleared plus the 40% slowly cleared) are presumed to go back up through the tracheo-bronchial system to nasopharynx and thence to intestine.

This model is totally based upon the assumption of normally functioning epithelium of the bronchial system, particularly of normally functioning cilia* to propel the particles

*Cilia are specialized hair-like structures arising from the surface of lining cells, with the function of propelling material.

672

back up the tracheo-bronchial tree. If that ciliary function is impaired, then all the assumptions concerning clearance rate can be vastly in error, if applicable at all.

While the Task Group of ICRP was quite happy that the model seemed in reasonable accord with experimental animal data on a variety of particulate materials, the model may be irrelevant for humans in real-life circumstances.

Let us recall that most lung cancers (bronchiogenic cancers in man) occur in smokers of cigarettes. Roughly such cancers are 10x as likely in cigarette smokers than in non-smokers. This being the case, we really need to know what the circumstances of PuO_2 deposition and retention will be in cigarette smokers in the population, since this will overwhelmingly determine the bronchiogenic lung cancer effects.

In the extensive studies of lung cancer reported by the Surgeon General, [29] one outstanding set of facts was pointed out, based upon the work of Auerbach et al [30].

(a) There is considerable alteration of bronchial epithelium in cigarette smokers.

(b) There is a serious loss of ciliary presence in cigarette smokers (to say nothing of function of what cilia remain).

If our cigarette smokers have a serious loss of ciliary presence and function, of what use is a model that predicts clearances based upon intact ciliary function? We must face the possibility that, as a result of impairment or loss of ciliary function, PuO_2 deposited in the tracheo-bronchial epithelial region of man may be cleared extremely slowly. Further, the PuO_2 coming back up from the deep pulmonary tissue may also be hung up in the bronchial region, since it is assumed that the ciliary function is what propels it on, ultimately to the intestine.

It will indeed be no easy task to ascertain, for cigarette smoking humans, precisely what the clearance rates are for PuO_2 in human bronchial tissue. But it would

represent the height of public health irresponsibility either (a) to assume that an invalid, irrelevant model provides answers or (b) to neglect the problem simply because it is difficult.

An approach to Estimation of the Plutonium Dose to Relevant Bronchial Cells

There are two parts to this estimate:

(a) Estimation of the fraction of tracheo-bronchial region that is relevant for bronchiogenic cancer.

(b) Estimation of the clearance of PuO_2 particles by bronchial epithelium with impaired ciliary function, as in cigarette smoking humans.

(a) Estimation of the Relevant Part of the Tracheo-Bronchial Region

In the Task Group publication [28] it is estimated that the air volume of naso-pharynx plus tracheo-bronchial region down through terminal bronchioles is 133 cm^3, of which 50 cm^3 is assigned to the nasopharyngeal volume. This leaves 83 cm^3 for the entire tracheo-bronchial region. Since virtually no cancers arise in the trachea, we can subtract approximately 33 cm^3 for the tracheal volume, leaving 50 cm^3. The right and left main-stem bronchi (also rarely involved in cancer) represent a volume of approximately 11 cm^3, so this leaves 39 cm^3 for the bronchial region, including the terminal bronchioles. As a reasonable first approximation, 1/2 of this volume will be assigned to the relevant bronchi, and 1/2 to the volume of smaller bronchial branches plus bronchioles. Therefore, we have, finally, approximately 20 cm^3 for the volume in relevant bronchi. From Gray's Anatomy [31], the diameter of such intrapulmonary bronchi can be estimated as approximately 0.23 cm. (or radius = 0.115 cm.).

Treating these bronchi as cylindrical tubes,

Volume = $\pi r^2 h$, where h = equivalent length of total bronchi of this class

$$20 = 3.14\ (0.115)^2\ h$$

$$\text{or, } h = \frac{20}{(3.14)(0.013)} = \frac{20}{0.04} = 500 \text{ cm.}$$

To calculate the surface area of such bronchi, we use:

$$\text{Area} = 2\pi r h$$
$$= 2\,\pi\,(0.115)\,500$$
$$= (6.28)(0.115)\,(500)$$
$$= 361\ \text{cm}^2$$

A reasonable approximation for average height of the stratified columnar epithelium of these bronchi is 30 microns, or 3×10^{-3} cm.

Therefore, Volume of Epithelial Tissue = Area x cell layer height

$$= 361 \times 3\times10^{-3} = 1083\times10^{-3}$$
$$\simeq 1\ \text{cm}^3.$$

Since the density of soft tissue is $\sim$1 gram/cm^3, it follows that the mass of relevant bronchial tissue is $\sim$1 gram.

(b) Estimation of the Clearance of PuO_2 Particles by Bronchial Epithelium with Impaired Ciliary Function

The work of Auerbach et al (cited in the Surgeon General's Report on Smoking) shows the following severe losses of cilia in cigarette smokers (Table 5). These were controlled studies in which the pathologist did not know the smoking habits for the cases studied.

The Surgeon General's report comments as follows on loss of ciliary function (Ref. 29, pp 269-270:

> "Inhibition of ciliary motility following exposure to tobacco tars, cigarette smoke, or its constituents has been demonstrated frequently with experimental use of respiratory epithelium from a wide variety of animal species." (17 references quoted).
>
> "Similar results have been obtained with ciliated human respiratory epithelium." (2 references). "Although all investigations have been conducted in vitro, the uniformity of the inhibitory effects in a number of different experimental models is impressive."

Table 5 (Data of Auerbach et al)

Loss of Cilia and Epithelial Cell Abnormality

Group	# Cases	# Slides studied	Percent of slides with cilia absent and averaging 4 or more cell rows in depth.
Never Smoked regularly	65	3324	1.1%
Ex-Cigarette Smokers	72	3436	4.1%
Cigarettes - 1/2 pk/day	36	1824	4.7%
Cigarettes - 1/2-1 pk/day	59	3016	7.9%
Cigarettes - 1-2 pks/day	143	7062	16.9%
Cigarettes - 2+ pks/day	36	1787	37.5%

As noted in Table 5, over and above the loss of cilia there is marked abnormality in the epithelial layer of the bronchi.* Whether these altered epithelial cells may more avidly engulf PuO_2 particles than do normal epithelial cells, either by phagocytosis or endocytosis, is totally unknown. It is possible that the failure of clearance of PuO_2 by such regions may be seriously enhanced over and above the failure of clearance due to the absence of cilia. The Auerbach data reveal the absurdity of the model used by ICRP, by Cohen, and by BMRC for evaluation of PuO_2 clearance by the real population expected to be exposed to PuO_2 inhalation. In the heavy smokers, who will contribute most of the lung cancers, 37.5% of the cells have lost their cilia entirely. We can, therefore, with sound reason, presume that such regions of absent ciliary function will clear PuO_2 particles very slowly, if at all. It would not be at all conservative, for such regions, to assume that the half-time for clearance is 500 days for PuO_2 particles.

*Normal epithelium would show one or two cell rows in depth. Note that Table 5 describes the slides showing four or more cell rows in depth.

Quantitative Treatment of Smokers and Non-Smokers For Plutonium Lung Cancer Hazard

Inasmuch as the strong evidence indicates a different physiological handling of PuO_2 particulates for smokers versus non-smokers (henceforth, smokers will be considered to mean cigarette smokers), it is essential to consider these as separate sub-populations. The first step in such separate handling is to re-estimate the risks of lung cancer for smokers versus non-smokers.

For the overall male population (USA), the spontaneous lung cancer rate = 1.27×10^{-3}/year. (P.5, this report). Two subpopulations will be considered as a very reasonable approximation:

1/2 the men as non-smokers

1/2 the men as smokers (all cigarette smokers combined).

Let x = lung cancer rate for non-smokers

and 10x = lung cancer rate for smokers (P.15, this report).

Then, overall rate = (1/2) (x) + 1/2 (10x) = 1.27×10^{-3}

$$\text{or,} \quad \frac{11x}{2} = 1.27 \times 10^{-3}$$

$$x = 0.23 \times 10^{-3}/\text{year}$$

$$10x = 2.3 \times 10^{-3}/\text{year}$$

With these evaluations of (x) and (10x), it is possible to convert all tables presented above into separate tables for smokers and for non-smokers. Wherever risks are involved, values for smokers (compared with overall population) must be multiplied by $\frac{2.3 \times 10^{-3}}{1.27 \times 10^{-3}}$ or a factor of 1.81 .

Values for non-smokers (compared with overall population) must be multiplied by $\frac{0.23 \times 10^{-3}}{1.27 \times 10^{-3}}$ or a factor of 0.181.

677

Table 3 can now be converted to one which treats smokers and non-smokers separately. These converted data, utilizing the factors above (1.81 and 0.181), are presented in Table 6.

Table 6

Step 1 Calculation: Separate Data for Smokers and Non-Smokers

Lung Cancer Doses per Pound of Plutonium*

For Cigarette Smokers:

Estimate	"Lung Cancer Doses" per pound Pu^{239}	"Lung Cancer Doses" per pound Reactor-Pu
"Gofman-Tamplin"	76,000,000	411,000,000
"BEIR"	19,000,000	103,000,000
"Cohen:	4,030,000	21,700,000

For Non-Smokers:

"Gofman-Tamplin"	7,600,000	41,100,000
"BEIR"	1,900,000	10,300,000
"Cohen"	403,000	2,170,000

*Note: This is still a Step 1 calculation assuming plutonium distributed into the entire 570 grams of (bloodless) lung tissue mass.

Step 3 Calculations of Lung Cancer Hazard from PuO_2 for Smokers and Non-Smokers

(a) The Cigarette Smokers:

As a result of the presence of large regions of cilia-free bronchi, coupled with potentially impaired ciliary function in additional regions, it is highly reasonable to estimate that clearance from cilia-free bronchial regions will be comparable with that estimated for cilia-free pulmonary regions. This leads to $T_{1/2}$ = 500 days for clearance for such cilia-free regions. From Table 5, cigarette-smokers of more than 1 pkg. per day average ~25% cilia-free regions.

Therefore, if we assume 25% of bronchi will show impaired clearance, we can hardly be overestimating the effect. It may not be conservative enough.

In the ICRP Task Group Model it is assumed that

25% of inhaled PuO_2 deposits in pulmonary tissue

8% of inhaled PuO_2 deposits in tracheobronchial region.

It is further assumed by ICRP that only 60% of the PuO_2 deposited in pulmonary tissue is retained for long-term clearance and that none of the PuO_2 deposited in the tracheobronchial tree is retained for long-term clearance.

With impaired ciliary clearance for 25% of the bronchial region, we shall assume

(a) that 25% of that deposited in tracheobronchial tree is subject to retention. 25% of 8% = 2% of total. Moreover, we shall use ICRP's estimate that 40% of this clears within a few days, leaving 0.6x2 = 1.2% for long-term retention.

(b) Further, of the 40% coming up rapidly (as per ICRP) from the pulmonary region that 25% of this 40% is retained in the bronchial region. 25% of (40% of 25%) = 2.5% is retained, additionally, of which 60% is retained long-term. Long term, therefore = 1.5%. Therefore, total retained for long-term clearance becomes

1.2 + 1.5 = 2.7% in bronchial region.

The ICRP Model allows 60% of 25%, or 15%, of total to be retained in pulmonary region, providing dose to this region.

Since we have just calculated 2.7% to be retained in the bronchial region, it follows that the bronchial region has a radiation source = $\frac{2.7}{15}$, or 0.18 as strong as the pulmonary region.

But to estimate dose to bronchial region, we must also incorporate the estimated tissue mass (bronchial) irradiated. This was shown above to be one gram.

Therefore, the overall radiation dose to bronchial region

= (0.18)x(570)x (Dose to pulmonary region)

= (103) x (Dose to pulmonary region).

679

This dose, in the cigarette smokers, will completely dominate the additional dose received by the pulmonary region.

It is now possible to estimate the lung cancer doses per pound of PuO_2 by applying this factor of 103 as a multiplier for all the values for smokers in Table 6. The results of this calculation are presented in Table 7.

Table 7

Step 3 Calculation: Final Estimate of PuO_2-induced Lung Cancers in Cigarette Smokers

Estimate	"Lung Cancer Doses" per pound Pu^{239}	"Lung Cancer Doses" per pound Reactor-Pu
"Gofman-Tamplin"	7,830,000,000	42,300,000,000
"BEIR"	1,960,000,000	10,600,000,000
"Cohen"	415,000,000	2,240,000,000

The number of micrograms Pu per lung cancer dose is now readily estimated for the cigarette smokers. For example, from Table 7, the Gofman-Tamplin estimate is 7,830,000,000 lung cancer doses per pound Pu^{239}.

$$1 \text{ pound} = 4.54 \times 10^8 \text{ micrograms}$$

$$\text{Therefore, } \frac{7.83 \times 10^9}{4.54 \times 10^8} = \text{lung cancer doses per microgram.}$$

The micrograms per lung cancer dose is the reciprocal, or $\frac{4.54 \times 10^8}{7.83 \times 10^9} = 0.058$ micrograms.

In a similar fashion all the values of Table 7 can be treated to provide the estimates of Table 8.

Table 8

Final Step 3 Estimates of Micrograms Pu per Lung Cancer Dose in Cigarette Smokers

Estimate	Micrograms Pu^{239} per lung cancer dose	Micrograms Reactor-Pu per lung cancer dose
"Gofman-Tamplin"	0.058	0.011
"BEIR"	0.23	0.043
"Cohen"	1.10	0.203

(b) The Non-Smokers

For this population sub-group, the Auerbach data (Table 5) show the following:

Never Smoked Regularly: 1.1% of bronchial regions show cilia absent.

Ex-Cigarette Smokers: 4.1% of bronchial regions show cilia absent.

We shall weight the "never smoked" twice as heavily as the ex-cigarette smokers and arrive at a value of 2% as an average for bronchial regions showing cilia absent in a cross-section of non-smokers.

For the cigarette smokers, a value of 25% was used above for the bronchial regions showing ciliary absence. Therefore, we arrive at the estimate that, whatever dosage of the relevant bronchi is taken for cigarette smokers, the appropriate value for non-smokers is 2/25, or (0.08) of that dosage. The number of expected lung cancers from plutonium inhalation in non-smokers will therefore be (0.08)x(lung cancers expected in smokers).

Accordingly, Table 9, providing lung cancer doses per pound of Pu for non-smokers is derived from Table 7 by multiplying all values by (0.08).

Table 10, providing micrograms Pu per lung cancer dose, is derived from Table 8 by dividing all values by (0.08).

Table 9

Final Step 3 Estimates of PuO_2 Induced Lung Cancers per Pound in Non-Smokers

Estimate	Lung Cancer Doses per pound Pu^{239}	Lung Cancer Doses per pound Reactor-Pu
"Gofman-Tamplin"	626,000,000	3,380,000,000
"BEIR"	157,000,000	850,000,000
"Cohen"	33,000,000	179,000,000

Table 10

Final Step 3 Estimates of Micrograms Pu per Lung Cancer Dose in Non-Smokers

Estimate	Micrograms Pu^{239} per lung cancer dose	Micrograms Reactor-Pu per lung cancer dose
"Gofman-Tamplin"	0.73	0.14
"BEIR"	2.88	0.54
"Cohen"	13.8	2.54

In the treatment here, both for smokers and non-smokers, no crediting was given to diminished ciliary function over and above ciliary absence. It is quite possible that we have underestimated the hazard of plutonium inhalation as a result. Nevertheless, the preference is to understate the hazard wherever data are not absolutely firm, provided all concerned realize that there may well be an understatement.

GENERAL DISCUSSION

Are the Estimates Too High or Too Low?

It is evident from all the discussion up to this point that certain key parameters of physiological function are not available through direct experimental evidence for humans. One fact, however, is outstanding--that is the failure of authoritative bodies such as ICRP or BMRC to come to grips with the real-life problem of bronchopulmonary retention of PuO_2 particles in cigarette-smoking humans. This failure has led them to the use of a totally unrealistic and probably irrelevant model which drastically underestimates the lung cancer hazard of PuO_2 inhalation. One may ask whether the retention in bronchial tissue, secondary to loss of ciliary function, will really lead to a 500-day half-time for clearance of PuO_2 particles. We simply don't know, but it is just as reasonable to expect an even longer retention time as it is to hope for a shorter retention time. Since ciliary function is the mechanism counted upon for differentiating rapid clearance in the bronchi versus slow clearance in the pulmonary region, the absence of effective ciliary function makes it reasonable, as a first approximation, to expect clearance times to become identical.

If there be any intrinsic more rapid clearance mechanism (aside from cilia) for bronchial cells than for pulmonary cells, such mechanism is totally hypothetical. Indeed, the effect can be such as to worsen the estimates.

One may ask whether the metaplastic and hyperplastic epithelium of the bronchi of cigarette-smoking humans is more or less active in the engulfing of PuO_2 particles than is the normal epithelium. We simply don't know, but it is, a priori, equally probable that such epithelium can be less, equally or more active in engulfing PuO_2 particles. The burden of proof that metaplastic and/or hyperplastic epithelium is less active in engulfing PuO_2 particles would rest upon those who think it may be less active. From what we know about the general physiology of injured or inflammatory tissue, the expectation, if anything, is for greater phagocytic activity, not less. And this would make the PuO_2 carcinogenicity worse than calculated, not better.

The Hazard of Dispersal of Plutonium Oxide Aerosols

Cohen endeavored to show that plutonium dispersal was not as bad as general opinion has held it to be. The seriousness of his under-estimate of the cancer hazard of inhaled PuO_2 aerosols is evident in this report. Thus, comparison of Cohen"s 2,225,000 lung cancer doses per pound of Pu^{239} (Table 3) with the final "Gofman-Tamplin" estimate of 7,830,000,000 for cigarette-smoking humans, shows that Cohen is low by a factor of $\frac{7,830,000,000}{2,225,000}$, or 3520 times too low. Even for the non-smokers, his estimate is some 300 times too low.

In view of these serious under-estimates of the lung cancer hazard from inhaled Pu, most of his estimates of the hazard of plutonium dispersal will require scaling up by a factor of 3520 times.

Cohen, in his general thesis that plutonium, while very toxic, is not as toxic as many have thought, presented a calculation that insoluble reactor grade Pu is roughly

60 times more carcinogenic than benzpyrene. Benzpyrene is a now-famous substance, being one of the most potent chemical hydrocarbon carcinogens known. If we correct Cohen's estimate by the 3520 fold factor required, his estimate would then be that reactor grade Pu is roughly 211,000 times as carcinogenic as benzpyrene for smokers. It would seem that this revision would materially enhance the carcinogenic stature of plutonium for Cohen.

In consideration of "lung cancer doses" per pound of plutonium it must be recalled that this reflects the expected number of fatal lung cancers per pound of deposited plutonium. The question of how much of dispersed PuO_2 actually gets deposited is a wholly separate issue, based largely upon meteorology and dispersal conditions. Thus, if plutonium is dispersed and falls out over the ocean, there are few humans around to inhale it, so very few of the cancers can occur. On the other hand, dispersal with fallout in a city can lead to very drastic consequences in lung cancer fatalities.

It has been estimated that the nuclear weapons testing of the 1950s and 1960s has resulted in the worldwide fallout of some 11,500 pounds of plutonium-239 equivalent.[35] Some have suggested that if plutonium is so virulent a carcinogen as it appears to be, why haven't more cases of lung cancer occurred as a result of this fallout? The author has calculated the consequences of this plutonium fallout, and these consequences will be presented in a separate report.[32] Huntington has repeatedly raised the question of whether the increasing epidemic of lung cancer may be, in part, due to plutonium fallout.[33] Huntington may well have raised one of the most crucial public health issues of our time.

Comparison of Human Data with Experimental Beagle Data

The British Medical Research Council Report has reviewed the beagle dog studies of Bair and Thompson.[34] The initial depositions were between 3 nanocuries

and 50 nanocuries of Pu-239 per gram of bloodless lung. Even at the lowest level (3 nanocuries per gram of lung), essentially 100% of the dogs died of lung cancer. We know, therefore, that 3 nanocuries per gram of bloodless dog lung is at least one "lung cancer dose". As BMRC pointed out, the true "lung cancer dose" could be much lower, and on-going experiments at lower doses will be required to test this issue.

But, there are sufficient data already to compare the beagle evidence with the human calculations presented in this report.

3 nanocuries per gram = 3×10^{-3} microcuries per gram.

To scale to human, with a 570 gram bloodless lung we have

$3 \times 10^{-3} \times 570$, or 1710×10^{-3}, or 1.7 microcuries of Pu-239 is at least one "lung cancer dose".

Conversion to micrograms, $1.7 \times 16.3 = 27.1$ micrograms of Pu-239 is at least one "lung cancer dose".

In Table 8, "Gofman-Tamplin" estimates are that 0.053 micrograms is the lung cancer dose for cigarette smoking humans, and in Table 10, the similar estimates are that 0.73 micrograms of Pu^{239} is the lung cancer dose for non-smoking humans.

Curiously enough it has been overlooked that beagle dogs raised in laboratories are not in the habit of smoking cigarettes. If a relevant comparison is to be made with humans, the appropriate treatment would be to compare the beagle data with the estimates for non-smoking humans.

Let us compare these values directly:

For the beagle dog (a non-smoker): 27.1 micrograms Pu^{239} is at least one lung cancer dose.

For the human (non-smoker): 0.73 micrograms Pu^{239} is one lung cancer dose.

As the BMRC report pointed out, virtually 100% of the beagles developed lung cancer at 3 nanocuries per gram of bloodless lung. It would be in the realm of miracles that the 3 nanocuries/gram happened to coincide with one lung cancer dose. In all likelihood, the true lung cancer dose for non-smoking beagle dogs is lower than 3 nanocuries per gram, and quite possibly considerably lower, just as was pointed out by the British Medical Research Council Report. Since the beagle data are even now so close to the estimates calculated here, it seems virtually certain that the newer beagle data will not be even one order of magnitude away from the human estimates.

The Standards for "Permissible" Exposure to Plutonium, Occupational and for the Public-at-Large

The existing guidelines for "permissible" exposures to plutonium particulates permit:

(a) Occupational workers: Maximum lung burden = 0.016 microcuries.

(b) Public-at-Large: Permissible burden for the average person = 0.0005 microcuries.

Tamplin and Cochran[1], at the time of releasing their report, stated that the current guidelines make it extremely likely, indeed almost certain, that exposed individuals (occupationally-exposed) would develop fatal lung cancers.

It is of interest to test this prediction of Tamplin and Cochran against the calculations of this report, calculations that in no way depend upon the hot particle approach utilized by Tamplin and Cochran.

Predictions for Occupational Exposure

Since 16.3 micrograms represent 1 microcurie of Pu^{239}, the occupational permissible burden of 0.016 microcuries represents 0.26 micrograms of Pu^{239} equivalent.

For Cigarette-Smoking Workers:

1 lung cancer dose = 0.058 micrograms (Table 8). Therefore, each worker is permitted to acquire a lung burden of $\frac{0.26}{0.058}$, or 4.5 lung cancer doses. Since it only takes one lung cancer to kill a human, it is something of an overkill to guarantee 4.5 fatal lung cancers per worker. For these workers, therefore, we not only agree with Tamplin-Cochran, but we believe they understated the hazard.

For Non-Smoking Workers:

1 lung cancer dose = 0.73 micrograms (Table 10). Therefore, each worker is permitted to acquire a lung burden of $\frac{0.26}{0.73}$, or 0.36 lung cancer doses. Therefore, the expectation is that approximately one such worker out of three would develop fatal lung cancer at the permissible dose.

Predictions For the Public-at-Large

The implications of this report's calculations for the public-at-large are much more startling. The permissible average burden of 0.0005 microcuries of Pu^{239} corresponds to 0.0082 micrograms of Pu^{239} equivalent.

The population of the USA is roughly 1/2 non-smokers, 1/2 cigarette smokers. Since there are some 10^8 males per generation, at the current US population size, there are 5×10^7 cigarette smokers and 5×10^7 non-smokers.

Total lung cancer doses, for cigarette smokers,

$$5 \times 10^7 \times \frac{0.0082}{0.058} = 5 \times 10^7 \times 0.14 = 7 \times 10^6 \text{ lung cancer doses.}$$

Total lung cancer doses, for non-smokers,

$$5 \times 10^7 \times \frac{0.0082}{0.73} = 5 \times 10^7 \times 0.011 = 0.55 \times 10^6 \text{ lung cancer doses.}$$

687

Combining these, we have 7,600,000 extra fatal lung cancers that can be expected in USA males per generation if the population exposure to plutonium approached that which regulations now permit.

Since these lung cancers would occur over a 30-year period, the expectation would be for $\frac{7,600,000}{30}$, or 253,000 extra fatal cancers per year in men. Since the current lung cancer fatality rate, from all causes combined, is 63,500 per year in men, the conclusion must be drawn that governmental regulatory bodies are not disturbed over causing an additional four times as many lung cancer deaths as are now occurring.

Many serious public health experts consider 63,500 lung cancer fatalities per year to represent a most serious epidemic. How should they view the burgeoning plutonium-based nuclear fission energy economy, proceeding under regulatory standards that would permit a four-fold increase supplementary to this epidemic?

Supplemental Notes

Note 1: The BEIR relative risk percentage refers to adults. If it were restricted to 20-30 year old adults, the BEIR value might have to be increased even further than the 0.5% value used in this report (for BEIR). This entire present report, for consistency, compares all estimates for males in the 20-30 year age range (see p.3, this report).

Note 2: Calculation of fatal doses per pound of a toxic material of commerce may, at first glance, appear to represent an effort to exaggerate toxicity. This is incorrect. Indeed, it will be quite relevant, in the future, to describe all industrial pollutants in a similar manner. For substances handled in commerce in pound or ton quantities, a rational reference framework will be to require toxic or fatal doses per pound.

Some observers have pointed out that society has handled many highly toxic non-radioactive pollutants in pound or ton quantities. Since, in general, no careful followup studies have ever been made for most such pollutants, it may well be that a societal reappraisal of such non-radioactive pollutants is urgently indicated.

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Particularly, the following one of this series:
Gofman, J. W. and A. R. Tamplin. "Radiation Induction of Human Lung Cancer." Testimony presented at Hearings of the Joint Committee on Atomic Energy, 91st Congress, January 28, 1970. (Also informal report GT-108-70, Lawrence Livermore Laboratory).

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EXHIBIT C

A Direct Case of Plutonium Induction of Cancer in Humans

Attached hereto is Dr. Arthur R. Tamplin's analysis of the case of Mr. Edward Gleason, who handled a leaking carboy containing plutonium in solution and who later died of a synovial sarcoma of the hand with metastases.

I have personally reviewed Dr. Tamplin's analysis of the circumstances of this case. My opinion is directly supportive of Dr. Tamplin's analysis, namely, that the statistical probabilities are overwhelmingly in favor of plutonium being the cause of Mr. Gleason's cancer and his death from cancer.

APPENDIX B

Statement Submitted to Attorneys for Mr. Edward Gleason

Re: Edward Gleason, et al vs. NUMEC

by: Arthur R. Tamplin

The following is my analysis of the origin of Mr. Edward Gleason's soft tissue sarcoma that ultimately resulted in his death and of the Consultation Report, submitted by Dr. Niel Wald, dated Jan. 29, 1973.

Mr. Gleason unloaded, rotated, and loaded a crate containing a leaking carboy of plutonium-239 (Pu-239) solution. This could not have occured without contaminating the palmar surface of his left hand, which was bare. The question is: did this Pu-239 contamination cause Mr. Gleason to develop a sarcoma? Since radiation induced cancers are identical with those that occur spontaneously, it is necessary to consider the relative chances that the cancer was spontaneous or Pu-239 induced.

The United States Vital Statistics, record a death rate for malignant neoplasms (other than melanoma) of the skin in the upper extremity of less than one per million per year. Since synovial sarcoma is a rare form that often metastasizes and hence has a poor prognosis, its occurrence rate is certainly less than the total skin cancer death rate of one per million per year. Thus it is highly unlikely that anyone who handled this crate would spontaneously develop this sarcoma on the contaminated hand (less than one chance in a million).

Now let us consider what the chances are of the development of cancer as a result of plutonium contamination of the skin. Experimental data from plutonium contaminated animals demonstrate that injection of 1 microgram of Pu-239 into the skin of rats promptly produced cancer in up to 5% of the animals (Exhibit 1). The particular tumors are fibrosarcomas.

Now the analysis done by LASL indicated that the Pu-239 concentration was about 160 micrograms per milliliter. This is reason to suspect, since the volume of liquid was reduced, the Pu was actually more concentrated in 1963. But setting that aside, one drop would be expected to contain between 8 and 16 micrograms of Pu-239. One-one hundredth of a milliliter (a very small amount of liquid) would have been sufficient to

produce sarcomas in animals. There is little reason to doubt that this small amount of liquid (0.01 milliliter) or even more found its way below the surface of Mr. Gleason's palm. In this event, his chance of developing cancer would be one in twenty. This is at least 50,000 times higher than his chances of developing the cancer spontaneously. In other words, the evidence is overwhelming in favor of the tumor resulting from Pu-239 contamination.

The above relative probability is based upon data from animals. It is quite possible that man is more sensitive than animals to cancer induction by Pu-239. In fact, the biological evidence strongly suggests that man is more sensitive. Exhibit 2 is a case report of a nodule removed from a man. This nodule contained only 0.08 ug of Pu-239. Commenting on the histological examination of the lesion, the authors states,"The autoradiographs showed precise confinement of α-tracks to the area of maximum damage and their penetration into the basal areas of the epidermis, where epithelial changes typical of ionizing radiation exposure were present. The cause and effect relationship of these findings, therefore, seemed obvious. Although the lesion was minute, the changes in it were severe. Their similarity to known precancerous epidermal cytologic changes, of course, raised the question of the ultimate fate of such a lesion should it be allowed to exist without surgical intervention..." In this case, less than 0.1 ug of Pu-239 produced precancerous changes in human tissue. The dose to the surrounding tissue was very intense. There is every reason to believe that a smaller quantity of Pu-239 would have produced similar changes.

When I consider the above human and animal data together with the relative probability of 50,000, I can come to no other conclusion than that this sarcoma was a direct result of the contamination of Mr. Gleason's left palm by Pu-239.

Turning now to Dr. Wald's Consultation Report, it can be stated that he has presented no evidence to disprove the claim that this sarcoma was caused by Pu-239 contamination. I shall discuss Dr. Wald's report in the order that it was written.

According to the Division of Inspection Report submitted by Anson M. Bartlett on April 11, 1963, pages 29-30, the January 19 examination was conducted not on Mr. Gleason, but on his home, clothing and automobile. The single urine and feces

samples collected subsequent to January 20 gave negative results. The only thing that this demonstrates is that no detectable level of Pu-239 was found. Even following the injection of large volumes of Pu-239 solution into the skin and muscle of animals, the Pu-239 is slowly absorbed and appreciable fractions, up to 70%, remain at the site of injection. Moreover, of the quantity absorbed only a small fraction appears in the urine or feces (see page 3, Exhibit 3 and Exhibit 4). In Mr. Gleason's case we are concerned with only a very small volume of solution and hence we should not be surprised if we obtain negative results in an individual urine or feces sample. (See also Exhibit 5)

The physical examination performed by Dr. Roy E. Albert on January 23, 1963, has no relevance. One would expect no overt signs of radiation injury at this early date from the small quantity of Pu-239 which is at issue here. We are concerned here with the long term effects, not the acute effects.

The medical history of Mr. Gleason as recorded by Dr. Wald appears to be accurate, however, he omitted the conclusions of the Pathology Report of the Hospital for Special Surgery wherein the unanimous opinion of the pathologists was stated to be that this lesion was a synovial sarcoma.

The negative findings in the feces and urine in April of 1970 are of no more relevance than the similar findings in the January 1963 samples. The whole body counter has a detection limit of 0.3 u Ci of Pu-239. At issue here are quantities below 0.06 u Ci and, hence, well below the detectable limit.

There are three reasons for setting aside the negative findings in the initial tissue removed from Mr. Gleason. First, since the pathologist report indicated "no evidence of atypical or malignant changes," it is quite possible that this mass was unrelated to the sarcoma. Recall here that the histology of the small nodule in Exhibit 2 showed severe changes that resembled precancerous changes. Third, the site of contamination was not necessarily removed with the mass or it could have trimmed from the mass prior to production of the paraffin blocks and slides. Consider here that the nodule in Exhibit 2 was only 1/10 of a millimeter in diameter. Since Mr. Gleason eventually developed an infiltrating soft tissue sarcoma, and this original tissue removed showed no atypical change, there is no basis for

assuming that the origin of the sarcoma was included in this tissue mass.

The negative results on the clavicle specimen are also equivocal. The issue here is a small quantity of Pu-239 that remained localized in the palmar area of the left hand. This bone specimen indicates only that the amount of systemically absorbed Pu-239 was too small to be detected in this bon specimen.

None of these clinical findings are able to set aside the strong possibility that Mr. Gleason's sarcoma was a direct result of the plutonium contamination. The most likely course of events is that a small quantity of the Pu-239 solution (less the 0.01 milliliter) was deposited in the tissue below Mr. Gleason's palm. This may have occured through a small cut or via a sliver. The body then reacted to this material as a foreign body, and encapsulated it. Eventually, a lesion similar to that discussed in Exhibit 2 developed. This nodule progressed beyond the precancerous stage to become an infiltrating soft tissue sarcoma. The chances are some 50,000 times greater that the sarcoma developed in this fashion than that it occured spontaneously.

I think that it is important to point out that all of the information relevant to this case was available in 1963. Had Mr. Gleason been informed of the potential cancer risk subsequent to the incident, he could have informed his physicians. As a result they would probably have treated him more cautiously and the tradegy could have been substantially mitigated.

Exhibits

1 Lisco, Herman, et al, Radiology, Vol. 49, No. 3, Sept. 1947, pp. 361-363.

2 Lushbaugh, C.C., et al, Arch. of Dermatology, Vol. 86, Oct. 1962, pp. 461-464.

3 Vanderbeck, J. W., HW-66172, Hanford Laboratories Operation, July 25, 1960.

4 Matsuoka, Mr., et al, Health Physics, Vol. 22, June 1972, pp. 713-722.

5 Lisco, Herman and Walter E. Kesiekeski, American J. of Pathology, Vol. 29, No. 1, Jan. - Feb. 1953, pp. 305-321.

U. S. DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

----------X

THE STATE OF NEW YORK, :

Plaintiff, : AFFIDAVIT

-against- : 75 Civ. 2121 (MCC)

THE NUCLEAR REGULATORY COMMISSION, et al. :

Defendants. :

----------X

STATE OF NEW YORK)
: SS.:
COUNTY OF ALBANY)

SEVILLE CHAPMAN, being duly sworn, deposes and says:

1. I am the Director of the Scientific Staff of the New York State Assembly and also have a consulting practice. I received my Ph.D in physics from the University of California at Berkeley in 1938. After teaching for approximately 10 years at the University of Kansas and Stanford University, I joined the Cornell Aeronautical Laboratory, Buffalo, New York, in 1948 as a principal physicist and later rose to the position of Chief Scientist at that laboratory. During my approximately 22 years there, I directed and participated in a wide variety of research and systems development, particularly in applied physics, electronics, and aero-space systems. The curriculum vitae attached hereto as Exhibit "A" also provides information regarding my background. I make this affidavit in support of the State of New York's motion for a preliminary injunction.

698

2. I wish to address the question whether the air transportation of plutonium involves a risk of accidental dispersion which is greater then the risk involved in transportation by land or sea. This question cannot be answered merely by comparing general accident statistics regarding the various modes of transport. Rather one must look at the different types of crash environment which can be created in the various modes of transport. In this connection, the most striking point is the tremendously high speed at which airplanes travel, a speed many times faster than that of trucks, trains or ships. Even at a landing speed of 150 miles per hour, plane speed well exceeds maximum speed on land or sea. Of course, the environment in a given crash is affected by factors other than vehicle speed. However, the difference between vehicle speeds in the air and those on land or sea is so great that it is clear that air transportation presents a substantially greater risk of extremely high impact on the container and resulting accidental dispersion than do the other modes of transportation, given the kinds of containers presently employed to transport plutonium. Certainly the containers presently employed do not provide assurance of withstanding the environments which exist in some kinds of air crash.

3. Other aspects of possible air crash environments, besides vehicle speed, highlight the danger of air transport of plutonium. For example, planes flying at a relatively great speed have been known to crash into mountains, as occurred near Washington, D.C., not very long ago. Planes may also crash into other relatively unyielding surfaces, such as elevated runways, as occurred in Buffalo some years ago. Moreover, an air crash may well result in a fire, which could aid in the dispersion of released plutonium.

4. I conclude that, given the kinds of containers presently employed to transport plutonium, the air transportation of plutonium involves a substantially greater risk of accidental dispersion than does land or sea transportation.

Seville Chapman
SEVILLE CHAPMAN

Sworn to before me this
11th day of June, 1975.

Anthony M. Rudmann
NOTARY PUBLIC

ANTHONY M. RUDMANN
Notary Public, State of New York
Residing in Schenectady County
478699490
My Commission Expires March 30, 19 76

700

December 1974

DR. SEVILLE CHAPMAN - Director, Assembly Scientific Staff, New York State Legislature; Independent Scientific Consultant

Education

A.B. and PhD., Physics, University of California, Berkeley

Professional Experience

New York State Legislature, Albany, New York 1971-
Director, Assembly Scientific Staff. In collaboration with the Ways and Means, Central, and Legal Staffs participates in legislative review on a day-to-day basis regarding scientific and technological matters; serves as a focal point to bring expertise in industries, universities, and government to bear in the planning of constructive legislation and long-term policy.

Office of Naval Research, Washington, D.C. 1971-
Scientific Consultant, atmospheric physics.

Cornell Aeronautical Laboratory, Buffalo, New York 1948-1970
Chief Scientist, responsible for sharpening the focus of proposals and 400 projects, both internal and under contract. Formerly Director of the Physics Division with 250 scientists and engineers in applied physics, electronics, avionics, aerospace systems, and operations analysis.

Stanford University 1941-1948
Assistant Professor of Physics

Memberships

American Association for the Advancement of Science, American Physical Society, Institute of Electrical and Electronics Engineers, American Geophysical Union, American Meteorological Society, American Institute of Aeronautics and Astronautics, American Society for Public Administration, American Association of Physics Teachers, Sigma Xi, Phi Beta Kappa, Cosmos Club

Listed in American Men of Science, World Who's Who in Science, Who's Who in Engineering, etc.

Boards, Committees, Awards

First member of Cornell Aeronautical Laboratory Technical Staff elected to Board of Directors, 1962-1965
Buffalo Society of Natural Sciences, member of Board, 1964-
Child and Family Services, Buffalo, member of Board, 1965- ; Vice President, 1970-
Life Institute, Minneapolis Medical Center, Inc., member of Board of Directors, 1973-1974

Buffalo Area Chamber of Commerce, Nuclear Development Council, 1962-1972. Chairman, Public Safety Council, 1970-1971
Member of various Pentagon Committees
Member Post Office Research and Engineering Advisory Council, 1966-1968
General Chairman, 117th National Meeting, American Meteorological Society
Outstanding Citizen Award, Buffalo Evening News, 1958
First award for Outstanding Contribution to Education, presented by Amherst Teachers Association, 1970

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"Electrostatic field measurements, corona discharge, and thunderclouds," Cornell Aeronautical Laboratory Report No. 68 (1956), 124 pp.

"Effective and inexpensive slits for teaching physical optics," (with Harold Meese), American Journal of Physics 25, 135 (1957).

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"Corona-point-discharge in wind and application to thunderclouds," Recent Advances in Atmospheric Electricity - Proceedings of the Second Conference on Atmospheric Electricity (Portsmouth, New Hampshire, May 20-23, 1958) (Pergamon Press, New York, 1958), pp. 277-288.

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"Engineering in the social context," IEEE Spectrum 8, No. 6, 13 (1971).

"Size, shape, and orientation of sonar targets measured remotely," American Journal of Physics 39, 1181-1190 (1971).

"Applying science to public technology," American Journal of Physics 41, 188-192 (1973).

702

"Scientists in state government," Physics Today 27, No. 6, 43-45 (1974).

"Science and public policy," Science 185, No. 4151, 568 (1974)

Total of 119 publications, including papers in professional journals, proceedings, abstracts, book reviews, etc.

In addition, for two decades contributed annually to about 100 reports, classified and unclassified.

AREAS OF EXPERTISE

Seville Chapman

October 1974

Physics
energy, mechanics, heat, light, sound, atomic and nuclear physics

Electrical Engineering
signal processing, electronics, computer technology, electric power

Meteorology
atmospheric physics, weather, climate, geophysics

Aerospace Systems
transport aircraft, missiles, management technology

Operations Research and Management Systems
systems analysis and synthesis

Environment
air, water, waste management, land use, coastal zone management

Research and Development
proposal preparation, project management

Interaction with all levels of
government, universities, industries

Professional Writing and Speaking

Social Services

Applying Science to Public Policy

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK, Plaintiff, v. THE NUCLEAR REGULATORY COMMISSION, ET AL, Defendants.	AFFIDAVIT 75 Civ. 2121 (WCC)

STATE OF NEW YORK)
: SS.:
COUNTY OF ERIE)

MARVIN RESNIKOFF, being duly sworn, deposes and says:

1. I have carefully reviewed the affidavits of Robert F. Barker, Donald A. Nussbaumer, and Herbert H. Kaiser, Jr., and the AEC report no. SC-DR-72 0597, titled, "Special Tests for Plutonium Shipping Containers 6M, SP 5795 and L-10" by L.F. Stravasnik of Sandia Laboratories. The above mentioned affidavits were submitted in opposition to the motion of the State of New York for a preliminary injunction.

2. The above mentioned afffidavits conclude that the risk from transportation of plutonium by air is very low because of, a. the low probability of an air accident, b. the high integrity of the plutonium shipping containers, c. the small dispersal and diffusion of plutonium, and d. the established procedures to mitigate the effects of any possible accident (Barker, para.57).

3. It is my opinion that the conclusion of para. 2 is not warranted by the evidence presented in the affidavits. Further, I find certain of the underlying assumptions of the affidavits either without basis or in contradiction with information prepared by the AEC in other documents. This affidavit will concern itself with the integrity of the containers and the dispersal and diffusion of plutonium, points b. and c. of para. 2. The affidavit of Dr. John Gofman will deal with the toxicity of plutonium and other points raised in Mr. Barker's affidavit.

4. My original affidavit considered the possibility of a breach of a plutonium shipping container, the dispersal of the

plutonium cloud, and the biological effects, including the number of cancer deaths. I concluded "that significant hazard does exist due to plutonium shipments by air transport." After carefully examining the rebuttal affidavits mentioned above, I remain convinced that the conclusions of my original affidavit are accurate and can stand the test of rigorous scientific scrutiny.

RUPTURE OF A SHIPPING CONTAINER

5. On page 6 of my original affidavit, I concluded, based on calculations in Appendix A, "that it is quite possible for this type of container to be punctured and the contents of one [illegible] fish' cans to be released." In para. 22, Mr. [illegible] agrees with this conclusion, in the following statement, "(While) his contention that it is possible to cause container failure by a sufficiently severe test mechanism of this sort is true..." However, Mr. Nussbaumer qualifies this agreement by adding that "...the Sanida study indicates that crush and puncture environments are not frequently produced by aircraft accidents." In other words, Mr. Nussbaumer states that it is possible to crush or puncture a container, but that a probability of such an eventuality is low, as shown by the Sandia study. The affidavit of Peter Skinner criticizes this study in some detail.

6. Mr. Nussbaumer arrives at a further conclusion regarding the safety of the plutonium shipping containers based on Sandia study, SC-DR-72 0597, "Special Tests for Plutonium Shipping Containers 6M, SP 5795 and L-10", by L.F. Stravasnik. Container 6M is a standard plutonium shipping container discussed in my original affidavit. It is noteworthy to point out that in 3 out of 3 test drops from 270 feet, the pressure vessel in the 6M container leaked from around the threads of the 4 inch pipe plug. Yet Mr. Nussbaumer concludes, in para. 24, that "the (Sandia) tests demonstrated the ability of the package designs to retain their contents when subjected to the severe tests." I fail to see how he arrives at this conclusion from the evidence.

Furthermore, the damage to the 6M container was sustained upon impact with a flat unyielding surface. A drop on an unyielding punch would be much more severe. My calculations, in Appendix A of my original affidavit, showed that a 300 foot drop on an unyielding punch would pierce the entire container.

7. Amount released. For calculational purposes, my original affidavit assumed that one half of one "tuna fish" can, about 1.25 kg., or 2.8% of a representative shipment, would be released. To put the matter more graphically, I assumed that a handful of plutonium would be released in an air accident.

Mr. Barker disagrees with this assumption in two ways. First he states that 1.25 kg. of Pu does not constitute half of the contents of a "tuna fish" can, but "the total contents of one of the two cans inside each shipping container." My assumption is based on the fact that a standard 6M shipping container may carry 4.5 kg. of plutonium dioxide (49 CFR 173.396(c)(2)(ii)), and 1.25 kg is approximately one quarter of the shipping container, and one-half of one of the two cans inside each shipping

container. I further stated, on page 8 of my original affidavit, that it is possible that no PuO_2 would be released, or that much more would be released, but for calculational purposes, I assumed that the release of a handful of plutonium in an air accident is a reasonable amount.

Mr. Barker disagrees with my assumption in a second way. He asserts that a release of 0.1% "is supported by studies made in the laboratory and of actual accident conditions."(para. 28). None of the studies have been provided, however, his assertion about 0.1% released in actual accident conditions appears to be contradicted by his statement that no air accidents with plutonium material have in fact occurred. (para. 57). I further fail to see how laboratory studies could possibly model a situation as complex as an air accident.

II. SPREAD OF THE PLUTONIUM CLOUD

8. Deposition Velocity. The concentration of plutonium in the air is partly a function of how rapidly it settles out of the air and is deposited on the ground, the deposition velocity. Mr. Barker assumes a deposition velocity between 0.003 and 0.01 meters per second (para.35), though for his calculations, both 0.001 and 0.003 m/sec are used (para. 51). Mr. Barker states that a value of 0.001 m/sec vs. 0.003 m/sec would produce effects 4 times as large (para. 51). His assumptions on deposition velocity are contradicted by AEC literature.

The terminal velocity for various sized particles can be calculated from the Stokes' formula, and has already been calculated by the AEC in report no. UCRL-14702, "Deposition Velocity of Aerosols and Vapors on Pasture Grass", by H. Leonard Fisher, Table I. For particles of density 11.46 gm/cm3, and diameters

equal to 1, 2, 5, 10 and 20 microns, the deposition evlocities are 4×10^{-4}, 1.5×10^{-3}, 8.8×10^{-3}, 3.5×10^{-2}, and 1.4×10^{-1} m/sec, respectively. For a particle of diameter 1 micron, my assumed value of 10^{-3} m/sec is 2½ times larger than the UCRL value, thereby underestimating the health effects. There is no justification by Mr. Barker for his value of 0.003 m/sec, a factor 7½ times greater than the UCRL value. He further claims that "a velocity closer to 10 times higher may be more reasonable", which would be a factor 25 times greater than the previous AEC value. A value this low would underestimate the health effects by greater than a factor of 25.

9. Diffusion. My original affidavit considers three cases, labelled cases A, B, and C. Case C assumes a wind speed of 6 m/sec, a typical wind speed for Kennedy airport, and stability category C, slightly unstable. Case B assumes a wind speed of 1 m/sec, and stability category F. The plume is narrower than in case C, and does not disperse greatly from the center line of the plume. The plutonium dust concentrations are therefore greater within the path than case C. Case A is a highly unlikely possibility, and is, indeed, the limiting case. It would represent the maximum number of health effects since all the plutonium would settle in a highly populated area. It was therefore presented as a check on cases B and C, to check if the results of cases B and C appeared reasonable. The postulation of turbulence followed by calm for several days is highly unlikely; it is not expected that calm would persist for several days. A wind would begin again and some of the plutonium would settle elsewhere. If the plutonium settled within an equally populated area of the city, the health effects, in terms of the number of lung cancers, would be the same. That is, each person would receive a smaller

dose, but more persons would be affected; the numbers of lung cancers would be the same. This is the linear, non-threshhold, hypothesis, a radiation dose assumption which is generally accepted in the scientific community. This is fully explained in the affidavit of Dr. John Gofman.

To the contrary, Mr. Barker assumes, in para. 39, that if the plutonium is widely dispersed so that each person receives a small amount, though more persons receive a dose, that the harm to the general population would be less. This is not a generally accepted radiation hypothesis.

As regards case A, it should be borne in mind that indeed one all-cargo aircraft did crash in 1974 due to thunderstorm turbulence. This was a crash from mid-air (para. 10g of affidavit of Herbert H. Kaiser, Jr.).

10. Airport Exposure. Mr. Barker states that many less deaths will occur at the airport itself due to the plutonium. He states that since "JFK airport terminal is so large in area, should an air accident occur within half a mile of the terminal, the conditions of exposures of cases B and C would limit the affected population to about 10 to 20%, respectively, of the total population in the area." The width of the plume at a distance 1 kilometer from the point of release is about 300 and 1,000 feet for cases B and C, respectively. Mr. Barker presents no basis for his results, "10 to 20%". One is left to accept his numbers on faith.

CONCLUSION

11. This affidavit has been limited to a further discussion

of the integrity of the shipping containers and the dispersal and diffusion of the plutonium cloud. It has been shown that the assumptions made by Mr. Barker, Mr. Kaiser and Mr. Nussbaumer, which served to lower the estimates of lung cancer deaths in my original affidavit, are not warranted by the available evidence, and that certain of the underlying assumptions are either without basis or are in contradiction with other AEC documents. After examining the above mentioned affidavits, I remain convinced that the conclusions of my original affidavit are accurate and can stand the test of rigorous scientific scrutiny.

Marvin Resnikoff

Sworn to before me this
12th day of June 1975.

Audrey Kosielniak

AUDREY KOSCIELNIAK
Notary Public, State of New York
Qualified in Erie County
My Commission Expires March 30, 19 76

711

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

----------X

THE STATE OF NEW YORK, :

Plaintiff, :

v. : AFFIDAVIT

THE NUCLEAR REGULATORY COMMISSION, et al., : 75 Civ. 2121 (WCC)

Defendants. :

----------X

STATE OF NEW YORK)
COUNTY OF NEW YORK : SS.:
SOUTHERN DISTRICT OF NEW YORK)

PETER N. SKINNER, being duly sworn, deposes and says:

1. I am an Environmental Engineer in the office of the Law Department, State of New York and I make this affidavit in support of plaintiff's motion for a preliminary injunction. I have prepared this affidavit in association with Patrick Wang, a Doctoral candidate in the Columbia University School of Public Health.

After carefully reviewing the defendant's affidavits made in opposition to the plaintiff's motion for a preliminary injunction, we find that the defendants essentially confirm the plaintiff's calculations of the risk from an aircraft accident involving plutonium cargo.

2. Mr. Barker's calculations for dispersal of plutonium, when converted into probable lung cancer deaths utilizing the U.S. Environmental Protection Agency's epidemiological methodology, represent a number of probable lung canger deaths of a magnitude similar to Dr. Resnikoff's calculations. Indeed, Barker's results do not even include deaths of any persons at the airport (as many as 30,000). See Exhibit 1.

3. The Sandia Report "Severity of Cargo Accidents". Exhibit "C" to Nussbaumer's affidavit, states that:

A. About 50% of the plane accidents studied included impact accidents more severe than the free drop test (see Exhibit 2) in 10 CFR part 71 (30 feet on a flat unyielding surface). See Exhibit 3.

B. There is little or no data in existence to base the crush environment predictions on. See Exhibit 4.

C. Between 5% and 30% of those aircrashes studied could puncture the cannisters. See Exhibit 5.

D. Fires in aircraft exceed 10 CRF part 71 performance specifications (1475° F for 30 minutes in about 30% of the accidents studied. See Exhibit 6.

4. Mr. Barker's affidavit states that the wind blows toward the northwest from John F. Kennedy Airport, i.e. - toward Manhattan, only 3% of the time. This figure is misleading indeed. Review of the wind rose data and average speeds included in Exhibit 7 clarifies the issues greatly. It can be seen from these presentations that, in all seasons, wind blows in the direction of Manhattan and other boroughs of high population

density in an arc north to west, about 50% of the time. In the summer months, winds blow toward these areas, which have population densities in excess of 10,000 per square mile, 67% of the time.

Peter N. Skinner

PETER N. SKINNER

Sworn to before me this
13 of June, 1975

Assistant Attorney General
of the State of New York

In view of the risk of aircraft accidents involving plutonium oxide transport that may result in significant harm to substantial numbers of people, I have evaluated the data (Barker's Tables 1-9) which Brookhaven National Laboratory (BNL) has provided to Robert F. Barker. I calculated the total probable lung cancer deaths that would occur if all the assumptions the BNL has provided in the nine tables in Mr. Barker's affidavit were used and summarized the results in attached Tables A and B.

The E.P.A. figures of 50 probable lung cancer deaths per million person-rems (P.C-18, E.P.S. 520/9-73-003-D) were used to calculate the total number of cancer deaths under the conditions provided by the BNL.

Each dose equivalent was multiplied by the corresponding population exposed for a given population density. Then this figure was multiplied by the E.P.A. figure of 50 probable lung cancer deaths per million person-rems in order to calculate the number of probable lung cancer deaths. A plot was made of population density per square mile versus number of probable cancer deaths. From the graphs (see graphs 1-9) one can estimate the number of probable lung cancer deaths corresponding to any given population density.

Based on information received directly from Westinghouse Laboratories in Cheswick, Pa. it was assumed that 100% of the reactor plutonium oxide is of inhalable size. It was also assumed that population doses are directly proportional to population density.

The conversion of population doeses into lung cancer deaths indicates clearly that Mr. Barker's analysis is consistent with Dr. Resnikoff's conclusions regarding the number of probable lung cancer deaths. This conclusion is that the release of 10,000 curies into the air would result in thousands of probable lung cancer deaths.

EXHIBIT "1"

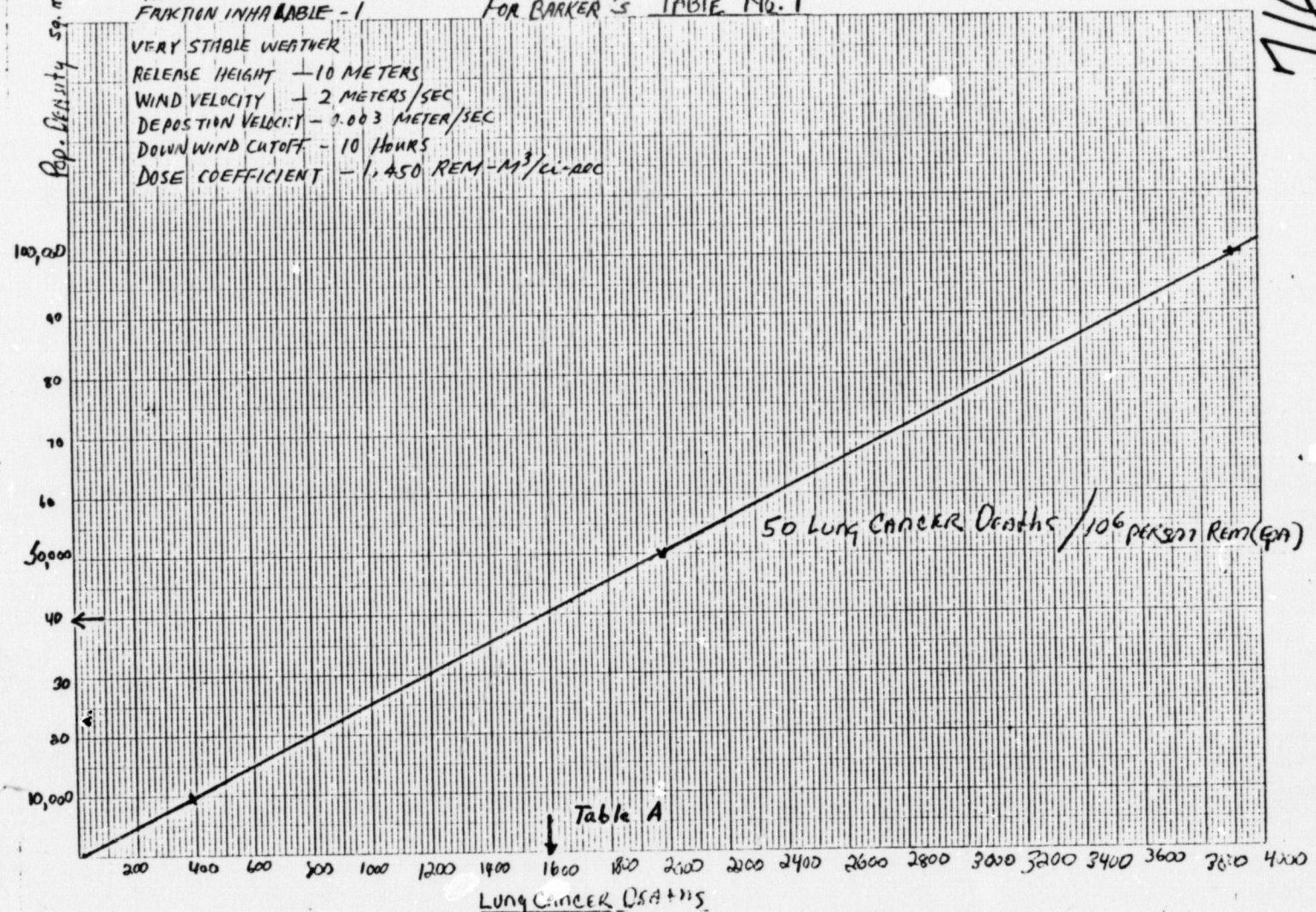
715

Exhibit 1.

716

REACTOR PU — 10,600 CURIES
FRACTION INHALABLE - 1
VERY STABLE WEATHER
RELEASE HEIGHT — 10 METERS
WIND VELOCITY — 2 METERS/SEC
DEPOSITION VELOCITY — 0.003 METER/SEC
DOWN WIND CUTOFF - 10 HOURS
DOSE COEFFICIENT — 1,450 REM-M³/Ci-sec

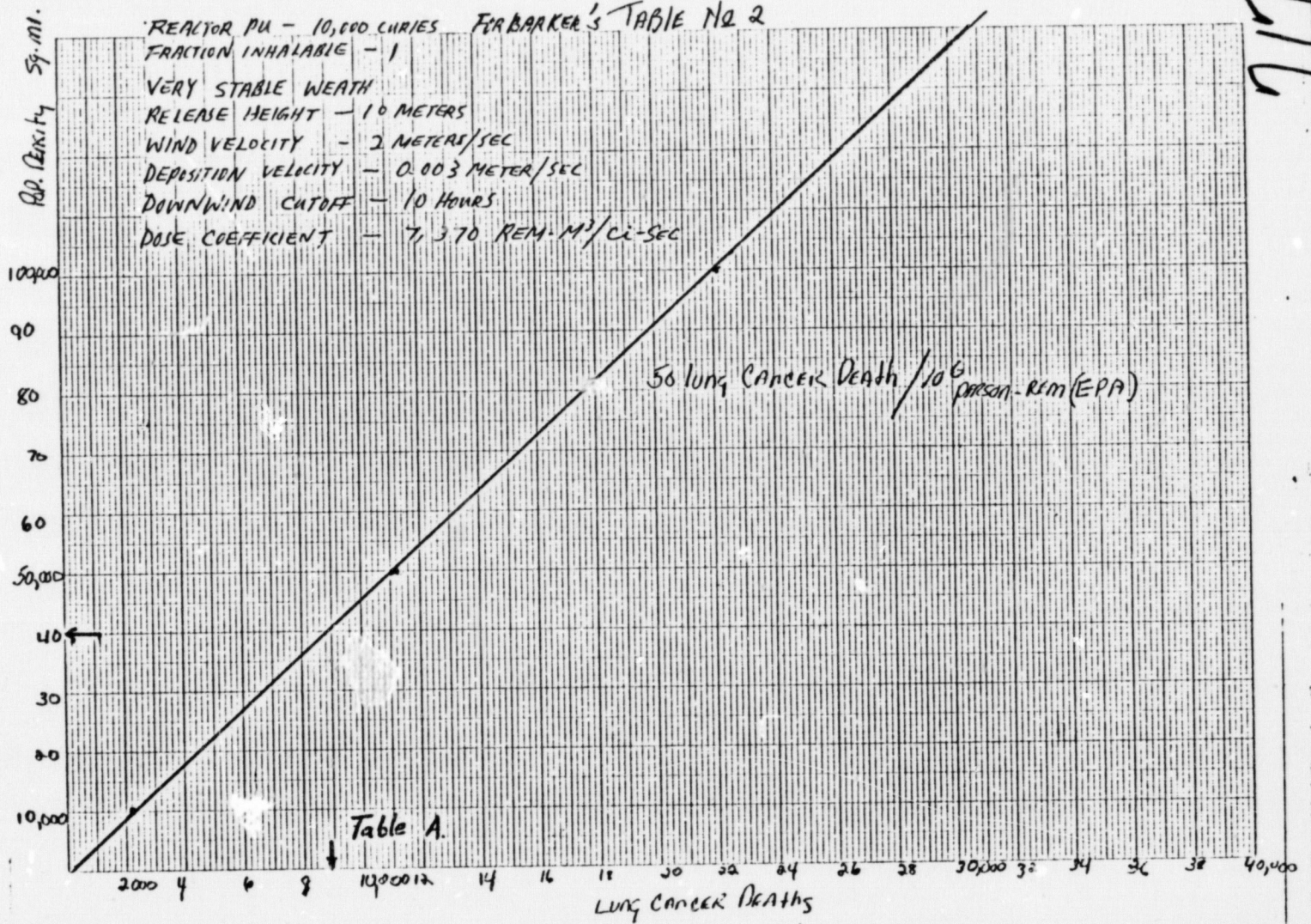
FOR BARKER'S TABLE No. 1



K&E 10 X 10 TO 15 INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1333

FOR BARKER'S TABLE NO 2

REACTOR PU – 10,000 CURIES
FRACTION INHALABLE – 1
VERY STABLE WEATH
RELEASE HEIGHT – 10 METERS
WIND VELOCITY – 2 METERS/SEC
DEPOSITION VELOCITY – 0.003 METER/SEC
DOWNWIND CUTOFF – 10 HOURS
DOSE COEFFICIENT – 7,370 REM·M³/Ci-SEC



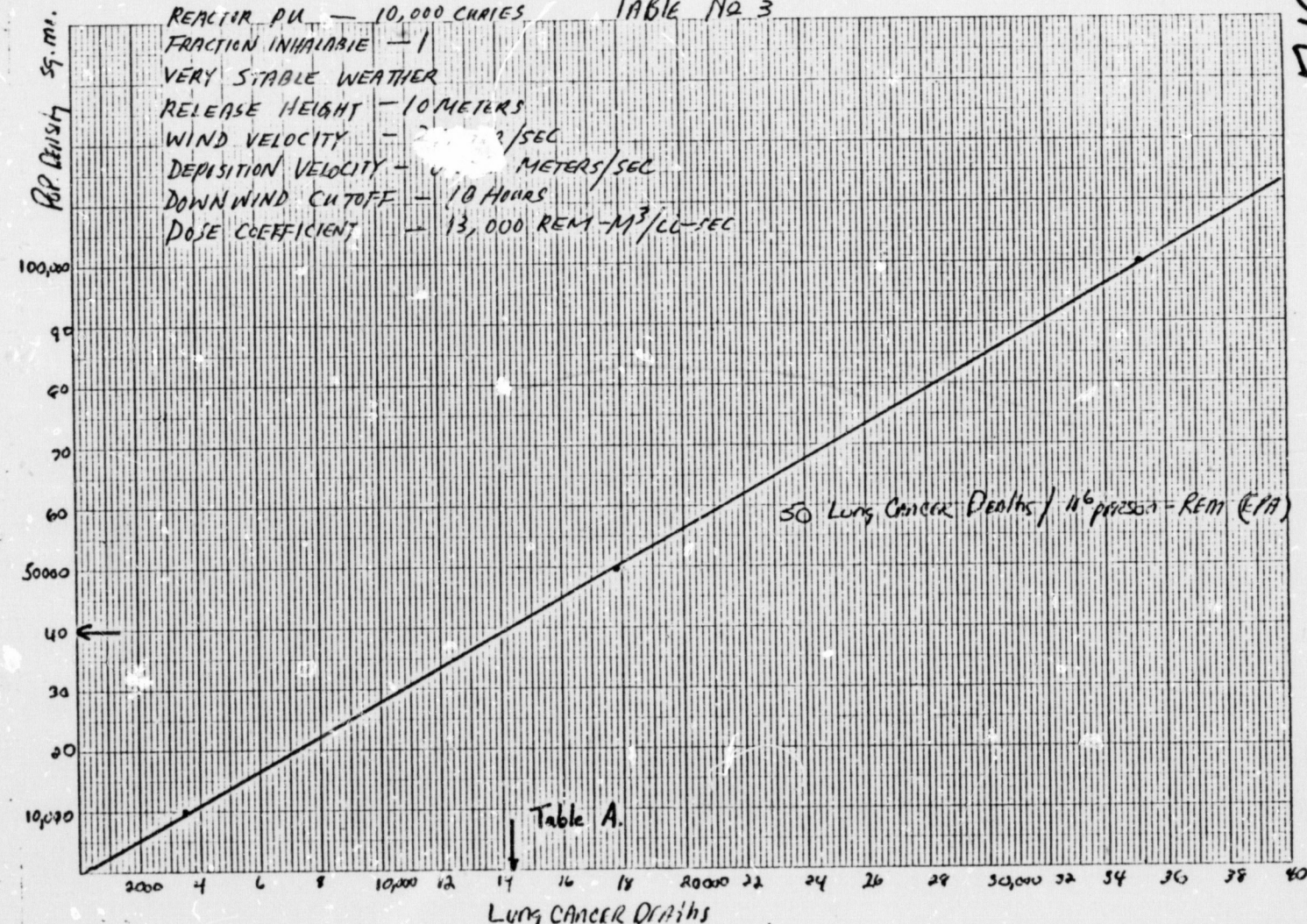
46 1333

GRAPH 3 FOR BARRACKS

TABLE No 3

718

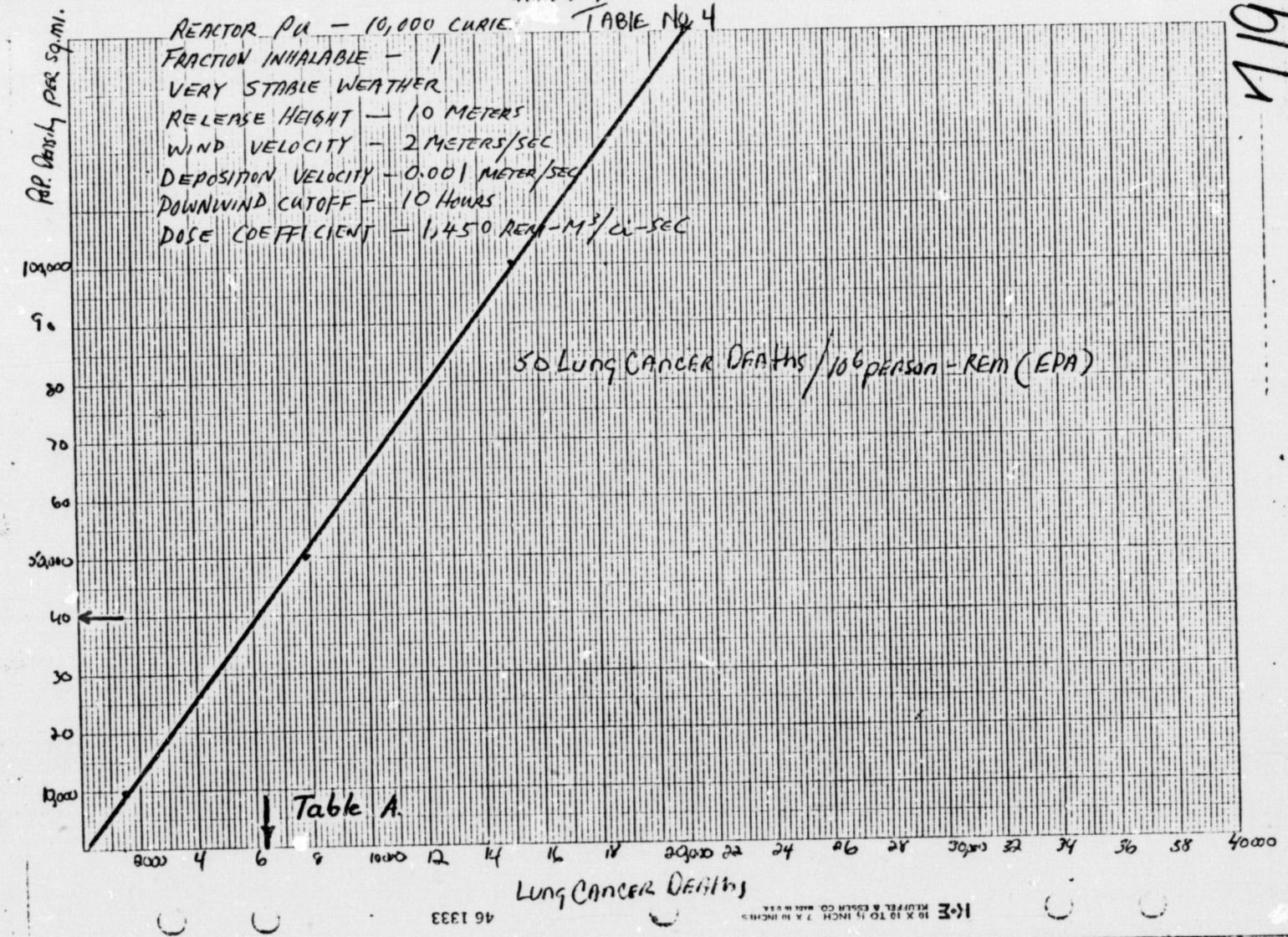
REACTOR PU — 10,000 CURIES
FRACTION INHALABLE — 1
VERY STABLE WEATHER
RELEASE HEIGHT — 10 METERS
WIND VELOCITY — [illegible] /SEC
DEPOSITION VELOCITY — [illegible] METERS/SEC
DOWN WIND CUTOFF — 10 HOURS
DOSE COEFFICIENT — 13,000 REM-M³/CC-SEC



46 1333
KEUFFEL & ESSER CO. MADE IN U.S.A.
10 X 10 TO 5 INCH 7 X 10 INCHES

GRAPH 4. FOR BAKER'S

TABLE No 4



716

46 1333
KEUFFEL & ESSER CO. MADE IN U.S.A. 10 X 10 TO ½ INCH 7 X 10 INCHES

TABLE No 5

REACTOR PU — 10,000 CURIES
FRACTION INHALABLE — 1
VERY STABLE WEATHER
RELEASE HEIGHT — 10 METERS
WIND VELOCITY — 2 METER/SEC
DEPOSITION VELOCITY — 0.001 METERS/SEC
DOWN WIND CUTOFF — 10 HOURS
DOSE COEFFICIENT — 7,370 REM-M³/Ci-SEC

Pop Density Sq. mi.

100,000
90
80
70
60
50,000
40
30
20
10,000

50 Lung Cancer Deaths/10⁶ person REM (Epi)

Table A

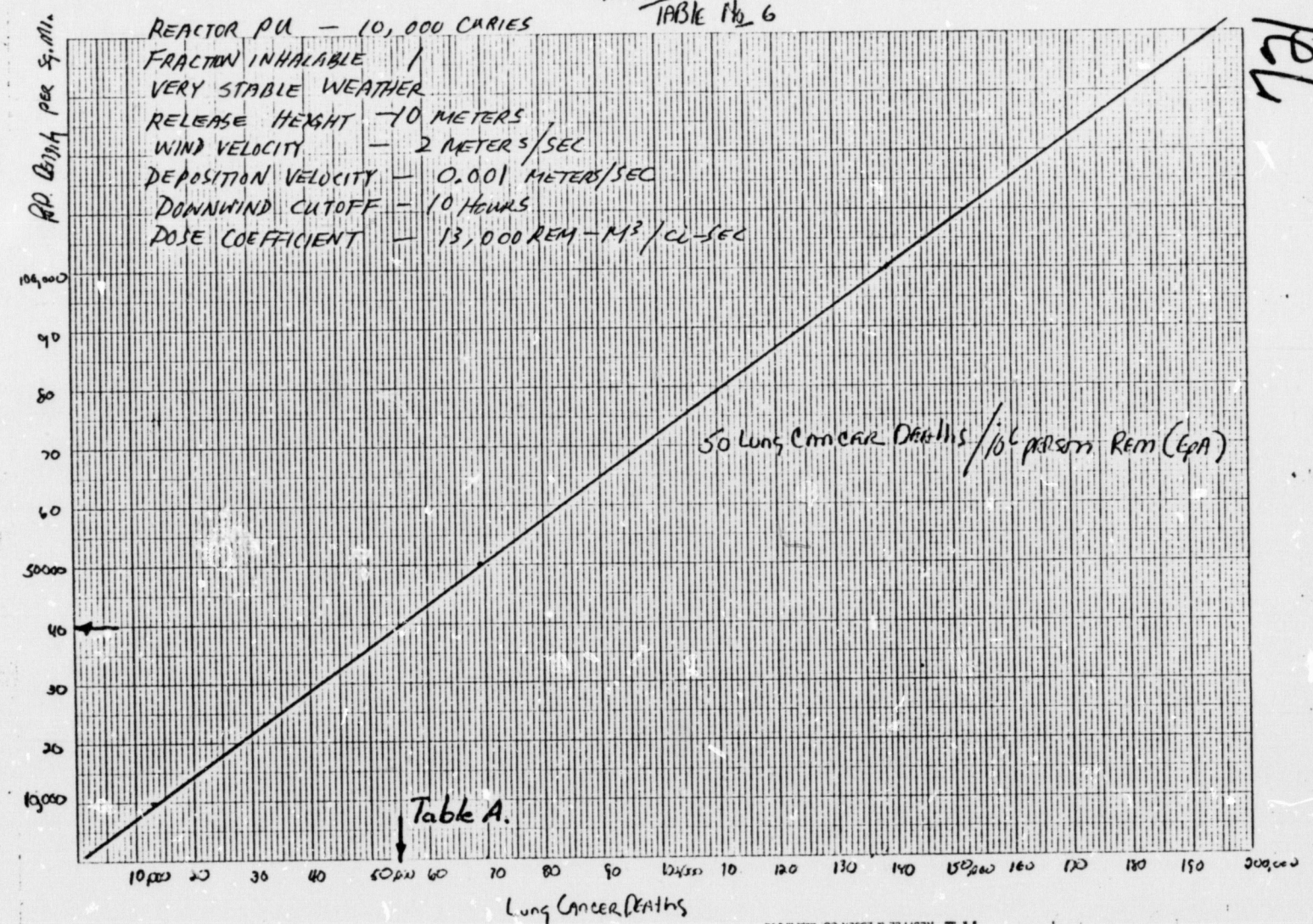
10,000 20,000 30,000 40,000 50,000 60,000 70,000 80,000 90,000 100,000

LUNG CANCER DEATHS

46 1333
KEUFFEL & ESSER CO. MADE IN U.S.A. 10 X 10 TO 5 INCH 7 X 10 INCHES

120

TABLE No. 6



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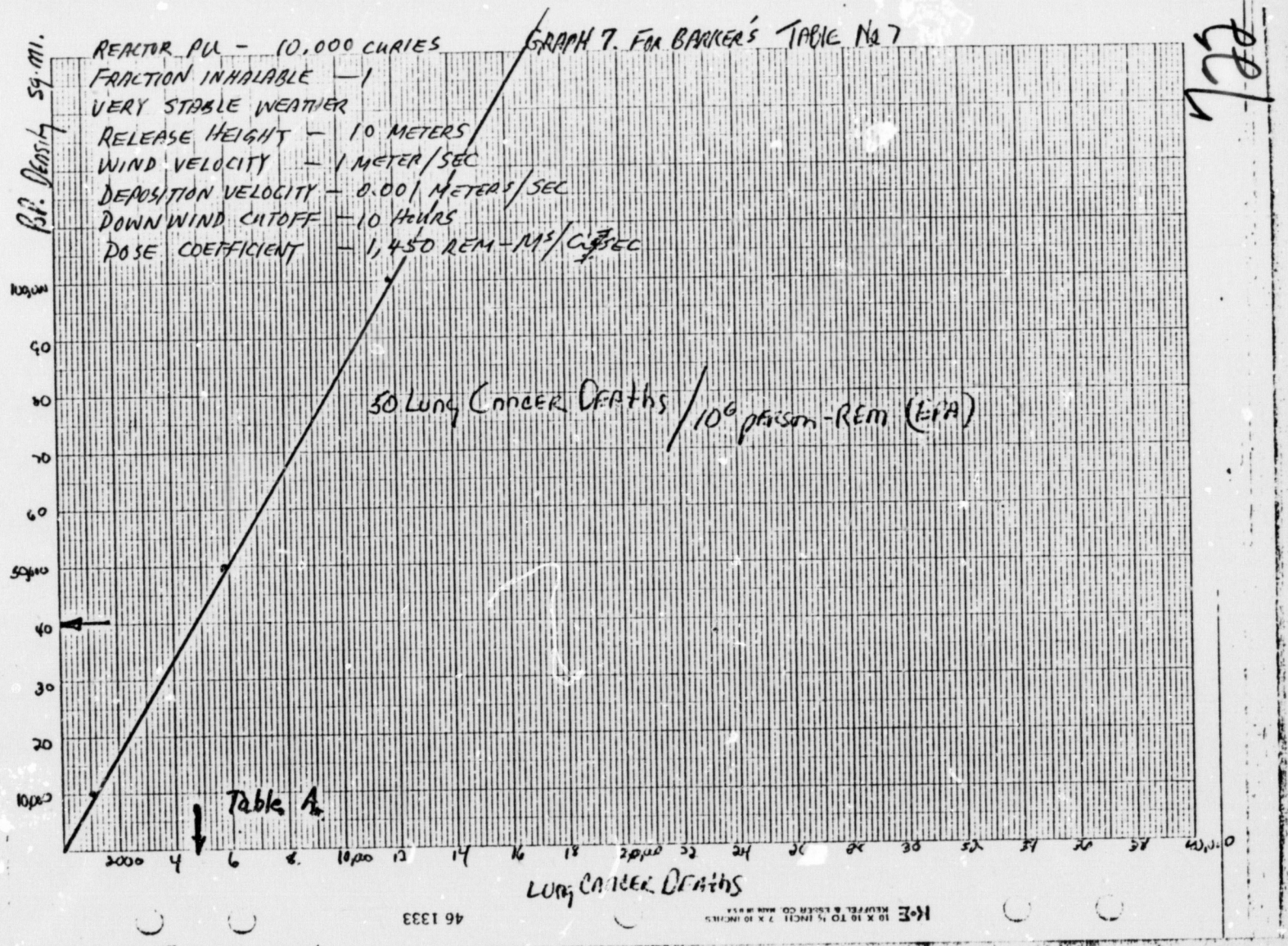
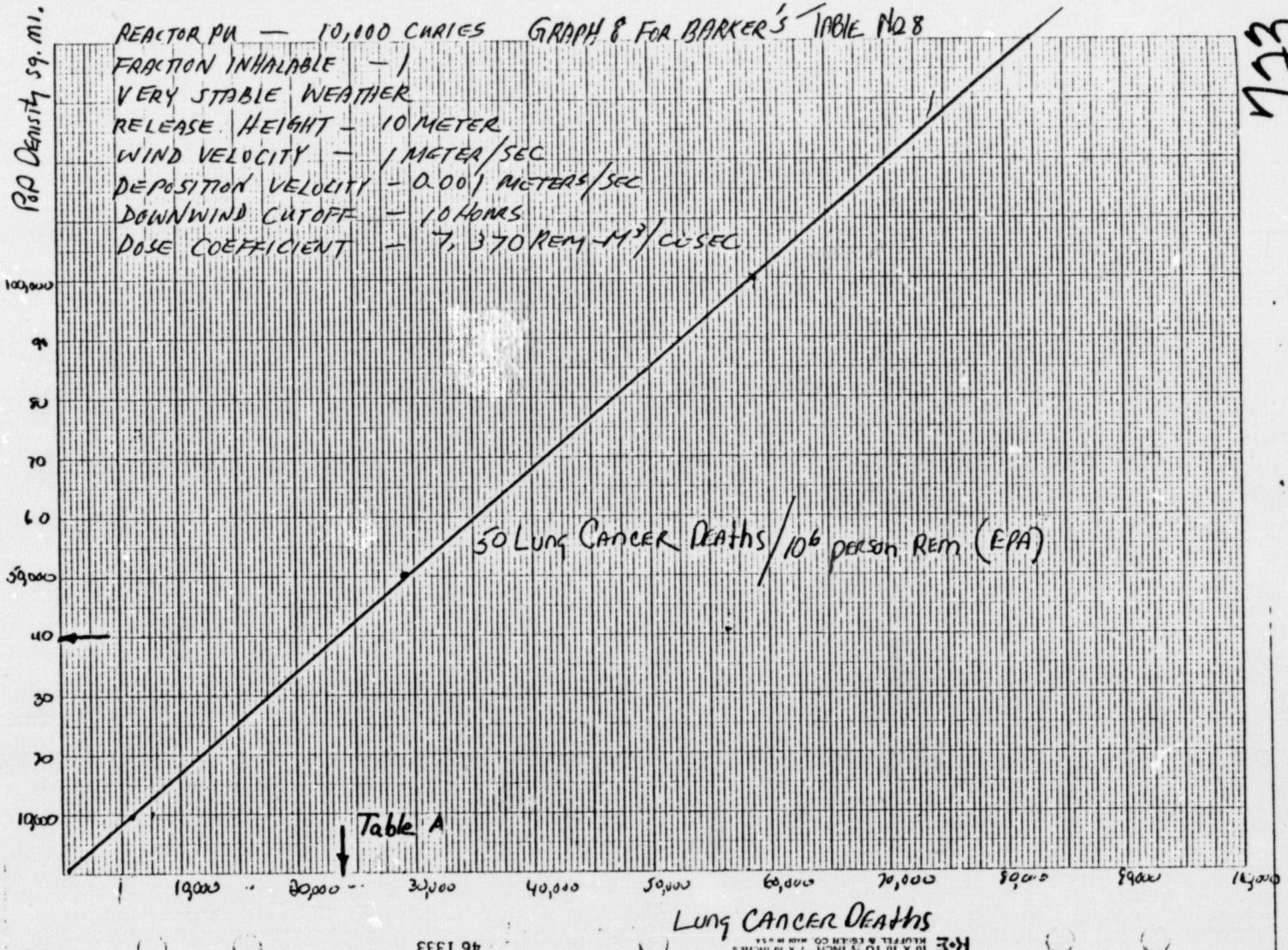

GRAPH 7. FOR BARKER'S TABLE No 7
REACTOR PU - 10,000 CURIES
FRACTION INHALABLE — 1
VERY STABLE WEATHER
RELEASE HEIGHT - 10 METERS
WIND VELOCITY - 1 METER/SEC
DEPOSITION VELOCITY - 0.001 METERS/SEC
DOWN WIND CUTOFF — 10 HOURS
DOSE COEFFICIENT - 1,450 REM-M³/CI SEC
Pu Density SQ. MI.
50 Lung Cancer Deaths / 10⁶ person-REM (EPA)
Table A
LUNG CANCER DEATHS
40
2000
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40.0

46 1333

REACTOR PU — 10,000 CURIES GRAPH 8 FOR BARKER'S TABLE NO 8
FRACTION INHALABLE — 1
VERY STABLE WEATHER
RELEASE HEIGHT — 10 METER
WIND VELOCITY — 1 METER/SEC
DEPOSITION VELOCITY — 0.001 METERS/SEC
DOWNWIND CUTOFF — 10 HOURS
DOSE COEFFICIENT — 7,370 REM-M³/CI SEC

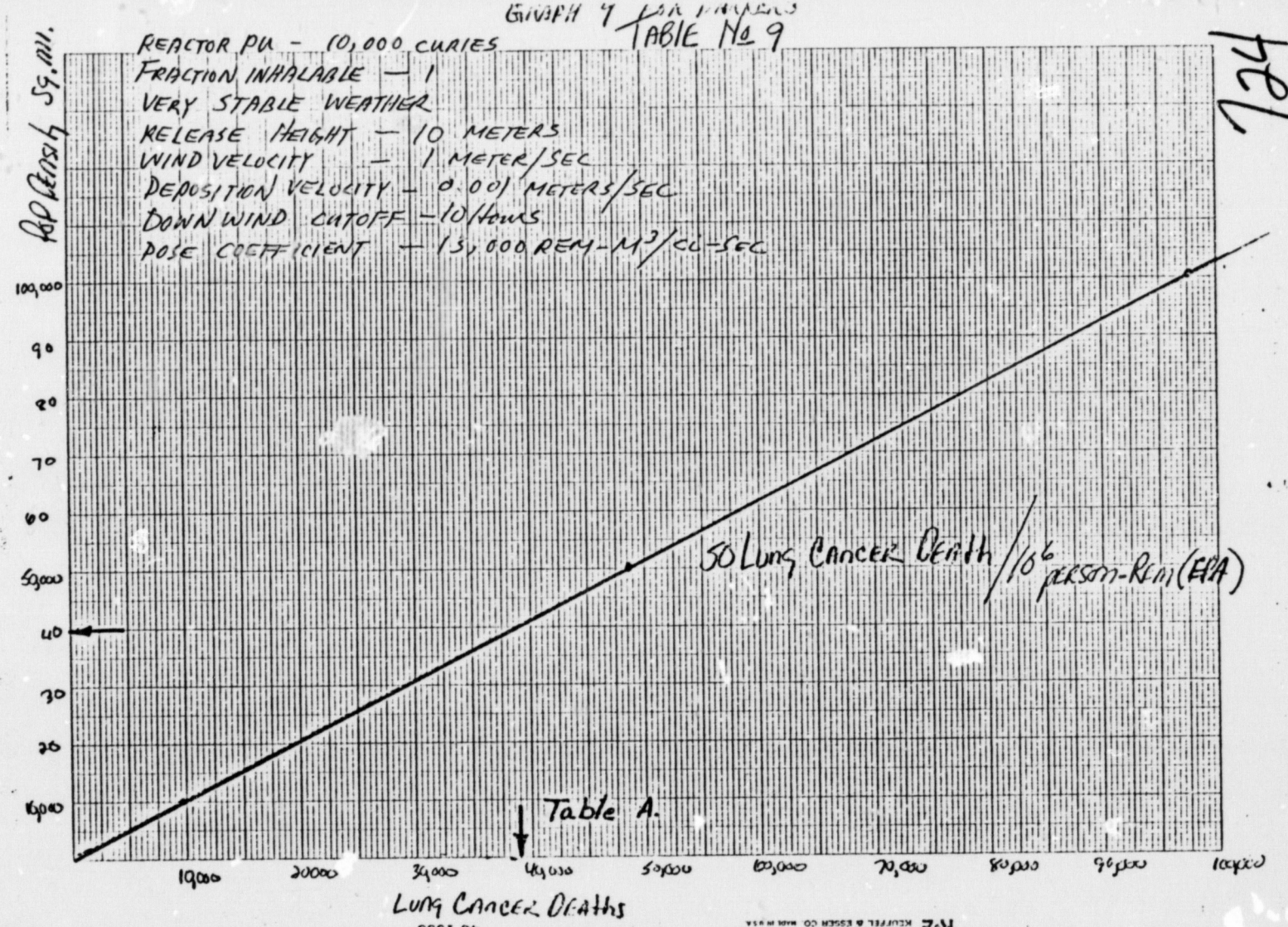


GRAPH 4 FOR PAPERS

TABLE No 9

124

REACTOR PU - 10,000 CURIES
FRACTION INHALABLE — 1
VERY STABLE WEATHER
RELEASE HEIGHT — 10 METERS
WIND VELOCITY — 1 METER/SEC
DEPOSITION VELOCITY - 0.001 METERS/SEC
DOWN WIND CUTOFF — 10 HOURS
DOSE COEFFICIENT — 15,000 REM-M³/CI-SEC



46 1333

K+E 10 X 10 TO 15 INCH 7 X 10 INCHES KEUFFEL & ESSER CO MADE IN U.S.A.

TABLE A

RESNIKOFF	LUNG CANCER DEATHS
CASE (A)	105,000
CASE (B)	76,700
CASE (C)	2,489

BARKER	LUNG CANCER DEATHS
50 L.C.D./10^6 PERSON-REM at 40,100/MILE^2	
TABLE (1)	1,576
(2)	8,812
(3)	14,336
(4)	6,368
(5)	32,648
(6)	54,832
(7)	4,756
(8)	23,468
(9)	38,760

TABLE B.

LUNG EXPOSURES RESULTING FROM
REACTOR PLUTONIUM
10,000 CURIES

50 LUNG CANCER DEATHS/10^6 PERSON-REM

REM DOSE EQUIVALENT	POPULATION EXPOSED (10,000 PER SQ MILE)	LUNG CANCER DEATHS.
0.1	392,036	2.00
0.2	346,603	3.00
0.5	294,523	7.0
1.0	260,391	13.0
2.0	230,214	23.0
5.0	117,585	29.0
10.0	66,695	33.0
20.0	37,816	37.0
50.0	17,824	44.0
100.0	10,034	50.0
200.0	5,556	55.0
500.0	2,296	57.0
1000.0	793	39.0
TOTAL (10,000 PSM)	1,782,366 →	392.0
(100,000) PER SQ MILE →		3920
(50,000) PER SQ MILE →		1960

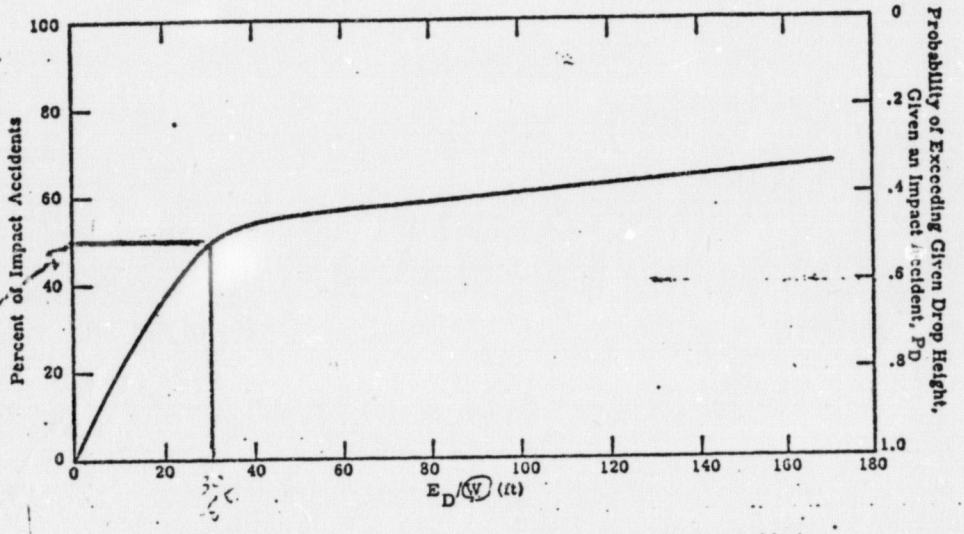


Figure C-2. Cumulative distribution of E_D/W in impact accidents (military or civil accident definition)

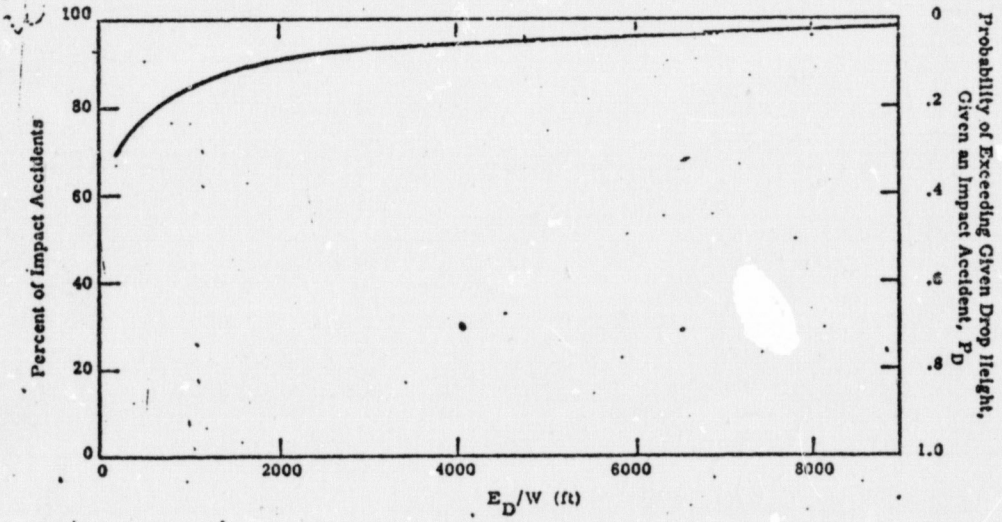


Figure C-3. Cumulative distribution of E_D/W in impact accidents (military or civil definition)

727

Exhibit 2

which are constructed primarily of wood or fiberboard, and do not exceed 110 pounds gross weight, and to all Fissile Class II packagings.

8. *Penetration*—Impact of the hemispherical end of a vertical steel cylinder 1¼ inches in diameter and weighing 13 pounds, dropped from a height of 40 inches onto the exposed surface of the package which is expected to be most vulnerable to puncture. The long axis of the cylinder shall be perpendicular to the package surface.

9. *Compression*—For packages not exceeding 10,000 pounds in weight, a compressive load equal to either 5 times the weight of the package or 2 pounds per square inch multiplied by the maximum horizontal cross section of the package, whichever is greater. The load shall be applied during a period of 24 hours, uniformly against the top and bottom of the package in the position in which the package would normally be transported.

APPENDIX B—HYPOTHETICAL ACCIDENT CONDITIONS

The following hypothetical accident conditions are to be applied sequentially, in the order indicated, to determine their cumulative effect on a package or array of packages.

1. *Free Drop*—A free drop through a distance of 30 feet onto a flat essentially unyielding horizontal surface, striking the surface in a position for which maximum damage is expected.

2. *Puncture*—A free drop through a distance of 40 inches striking, in a position for which maximum damage is expected, the top end of a vertical cylindrical mild steel bar mounted on an essentially unyielding horizontal surface. The bar shall be 6 inches in diameter, with the top horizontal and its edge rounded to a radius of not more than one-quarter inch, and of such a length as to cause maximum damage to the package, but not less than 8 inches long. The long axis of the bar shall be perpendicular to the unyielding horizontal surface.

3. *Thermal*—Exposure to a thermal test in which the heat input to the package is not less than that which would result from exposure of the whole package to a radiation environment of 1,475° F. for 30 minutes with an emissivity coefficient of 0.9, assuming the surfaces of the package have a absorption coefficient of 0.8. The package shall not be cooled artificially until 3 hours after the test period unless it can be shown that the temperature on the inside of the package has begun to fall in less than 3 hours.

4. *Water Immersion* (fissile material packages only)—Immersion in water to the extent that all portions of the package to be tested are under at least 3 feet of water for a period of not less than 8 hours.

33 F.R. 17621

APPENDICES

APPENDIX A—NORMAL CONDITIONS OF TRANSPORT

Each of the following normal conditions of transport is to be applied separately to determine its effect on a package.

1. *Heat*—Direct sunlight at an ambient temperature of 130° F. in still air.

2. *Cold*—An ambient temperature of −40° F. in still air and shade.

3. *Pressure*—Atmospheric pressure of 0.5 times standard atmospheric pressure.

4. *Vibration*—Vibration normally incident to transport.

5. *Water Spray*—A water spray sufficiently heavy to keep the entire exposed surface of the package except the bottom continuously wet during a period of 30 minutes.

6. *Free Drop*—Between 1½ and 2½ hours after the conclusion of the water spray test, a free drop through the distance specified below onto a flat essentially unyielding horizontal surface, striking the surface in a position for which maximum damage is expected.

FREE FALL DISTANCE

Package weight (pounds)	Distance (feet)
Less than 10,000	4
10,000 to 20,000	3
20,000 to 30,000	2
More than 30,000	1

7. *Corner Drop*—A free drop onto each corner of the package in succession, or in the case of a cylindrical package onto each quarter of each rim, from a height of 1 foot onto a flat essentially unyielding horizontal surface. This test applies only to packages

33 F.R. 17621

APPENDIX C—TRANSPORT GROUPING OF RADIONUCLIDES

Element*	Radionuclide***	Group
Actinium (89)	Ac 227	I
	Ac 228	I
Americium (95)	Am 241	I
	Am 242	I
Antimony (51)	Sb 122	IV
	Sb 124	III
	Sb 126	III
Argon (18)	Ar-37	VI
	Ar-41	II
	Ar-41 (unconfined).**	V
Arsenic (33)	As 73	IV
	As 74	IV
	As 76	IV
	As 77	IV
Astatine (85)	At 211	III
Barium (56)	Ba 131	IV
	Ba 133	II
	Ba 140	III

See footnotes at end of table.

APPENDIX C—TRANSPORT GROUPING OF RADIONUCLIDES—Continued

Element*	Radionuclide***	Group
Berkelium (97)	Bk 249	I
Beryllium (4)	Be 7	IV
Bismuth (83)	Bi 205	IV
	Bi 207	III
	Bi 210	II
	Bi 212	III
Bromine (35)	Br 82	IV
Cadmium (48)	Cd 109	IV
	Cd 115 m	III
	Cd 115	IV
Calcium (20)	Ca 45	IV
	Ca 47	IV
Californium (98)	Cf 249	I
	Cf 250	I
	Cf 252	I
Carbon (6)	C 14	IV
Cerium (58)	Ce 141	IV
	Ce 143	IV
	Ce 144	III
Cesium (55)	Cs 131	IV
	Cs 134 m	III
	Cs 134	III
	Cs 135	IV
	Cs 136	IV
	Cs 137	III
Chlorine (17)	Cl 36	III
	Cl 38	IV
Chromium (24)	Cr 51	IV
Cobalt (27)	Co 56	III
	Co 57	IV
	Co 58 m	IV
	Co 58	IV
	Co 60	III
Copper (29)	Cu 64	IV
Curium (96)	Cm 242	I
	Cm 243	I
	Cm 244	I
	Cm 245	I
	Cm 246	I
Dysprosium (66)	Dy 164	III
	Dy 165	IV
	Dy 166	IV
Erbium (68)	Er 169	IV
	Er 171	IV
Europium (63)	Eu 150	III
	Eu 152 m	IV
	Eu 152	III
	Eu 154	II
	Eu 155	IV
Fluorine (9)	F 18	IV
Gadolinium (64)	Gd 153	IV
	Gd 159	IV
Gallium (31)	Ga 67	III
	Ga 72	IV
Germanium (32)	Ge 71	IV
Gold (79)	Au 193	III
	Au 194	III
	Au 195	III
	Au 198	IV
	Au 199	IV
Hafnium (72)	Hf 181	IV
Holmium (67)	Ho 166	IV
Hydrogen (1)	H 3 (see tritium)	
Indium (49)	In 113 m	III
	In 114 m	III
	In 115 m	IV
	In 116	IV
Iodine (53)	I 124	III
	I 125	III
	I 126	III
	I 129	III
	I 131	III
	I 132	IV
	I 133	III
	I 134	IV
	I 135	IV
Iridium (77)	Ir 190	IV
	Ir 192	III
	Ir 194	IV
Iron (26)	Fe 55	IV
	Fe 59	IV
Krypton (36)	Kr 85 m	III
	Kr 85 m (unconfined).**	V
	Kr 85	III
	Kr 85 (unconfined).**	VI
	Kr 87	II
	Kr 87 (unconfined).**	V
Lanthanum (57)	La 140	IV
Lead (82)	Pb 203	IV
	Pb 210	II
	Pb 212	II
Lutecium (71)	Lu 172	III
	Lu 177	IV
Magnesium (12)	Mg 28	III
Manganese (25)	Mn 52	IV
	Mn 54	IV
	Mn 56	IV
Mercury (80)	Hg 197 m	IV
	Hg 197	IV
	Hg 203	II
Mixed fission products MFP.		II

See footnotes at end of table.

Exhibit 3

728

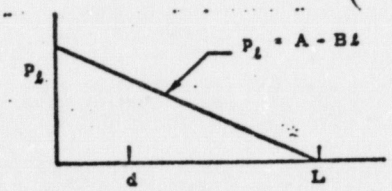


Figure D-3. Assumed p_ℓ functions

For this assumption, p_ℓ is set equal to zero at L (zero probability of the container being greater than L from the center of an aircraft piece). With the added restraint

$$\int_0^L p_\ell d_\ell = 1 ,$$

the density function becomes

$$p_\ell = \frac{2}{L} - \frac{2\ell}{L^2} ,$$

and

$$p_{ac} = \int_0^d p_\ell d\ell = \frac{2d}{L} - \frac{d^2}{L^2} .$$

With L = 600 ft and d = 27 ft

$$p_{ac} = .09$$

so that $p_{cp} = .09$ for two aircraft pieces. For four pieces, the result is

$$p_{cp} = .12 .$$

The probability of crush, given an impact accident, p_{ci}, calculated by this model is thus in the range

$$p_{ci} = .48(.09) = .043$$

to $\quad .48(.12) = .058 .$

Conclusions

The probability of crush, given an aircraft impact accident, has been estimated by two independent models to be in the range .01 to .06. For use in combination with the probabilities of fire, impact, puncture, and immersion, as estimated for the military accident sample (Appendix G), a nominal value of .05 (p_{13} in Appendix G) will be used. Crush as defined in this probability is assumed to result from a portion of the aircraft resting on top of a container after an impact accident. No attempt has been made to analyze the severity of the crush environment, given that crush occurs.

Exhibit 4, p1

729

Probability of Crush

There are no direct data available on the occurrence of crush. Therefore, an attempt will be made to estimate the probability of crush, given an accident, based on a model for physical overlap of a container and a portion of the aircraft, coupled with indirect data.

Only impact accidents which produce cargo compartment breaks are potential crush accidents. In the military data sample of 305 accidents, 149 accidents are classified as impact, with 72 of these having definite or probable fuselage breaks. Thus an estimate of the probability of crush potential is (letting Pr represent a probability)

$$\Pr\left\{\text{crush potential given an impact accident}\right\} = \frac{72}{149} = .48 .$$

Of the accidents with crush potential, only in some small fraction will crush actually result. This fraction is estimated with a model for the probability of overlap of the container and a portion of the aircraft. It is assumed that, in an impact accident, all pieces of the aircraft have some probability of coming to rest with their centers in an area of length L and width W, and zero probability of coming to rest outside this area. It is further assumed that the container has some probability of coming to rest in an area which includes the above area and may exceed it on all sides by at least d, the average distance from the center of an aircraft part to its edge. This situation is illustrated in Figure D-1.

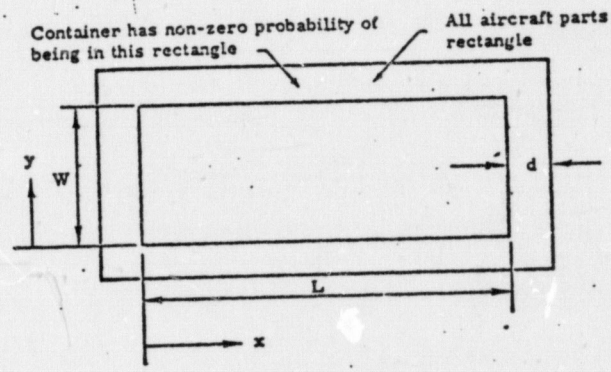


Figure D-1. Aircraft and container locations

Exhibit 4, p.2

The probability of the container impacting a corner or probe of sufficient stiffness to puncture it is small. All six containers which we have considered (and containers, in general) possess energy-absorbing material between the outside skin and the inner receptacle. To damage the inner container will require a probe several inches in length. The impact of the container on this probe must be symmetrical with respect to the container or little energy will be available for puncture. Also, if the probe is not sufficiently solid from a structural viewpoint, it will deform rather than penetrate the container. Consideration of these factors together with the relative absence of potential puncturing sources on the interior of an intact aircraft cargo compartment suggest that this probability of the free-flying container impacting a probe in a manner such that a puncture potential is present is no higher than .01.

If one assumes a linear relative velocity distribution for impact of the container on the probe, the percentage of accidents not protected against by a container that possesses a puncture velocity capability of U_p (ft/sec) is $(40 - U_p)/40$. Therefore, the probability of puncture (P_{D1}) at a velocity capability is

$$P_{D1} = (.25)(.01)(1 - .025\ U_p)$$

$$= .0025 - 6.3 \times 10^{-5}\ U_p .$$

The greatest uncertainty in these calculations is in the estimation of the probability of the container impacting a large enough rigid probe with the velocity and C_g of the container sufficiently aligned with the probe that damage is possible. If this probability is increased from one in a hundred accidents to what is believed to be a maximum of one in every twenty, then 1/20

$$P'_{D1} = (.25)(.05)(1 - .025\ U_p) = .0125 - 31.3 \times 10^{-5}\ U_p .$$

Puncture Probability if Aircraft Breaks Into Several Pieces

In our military data sample, 72 accidents resulted in definite or probable (not explicitly determinable from accident report) fuselage breaks. Of these 72, 31 produced 1, 2, or 3 major fuselage breaks, 32 produced essential aircraft disintegration, and the remaining 9 could not be reliably placed in either category. These 9 accidents will be arbitrarily split between "several breaks" and "disintegration" accidents so that the probability of the aircraft breaking into several pieces in an accident is estimated to be 36/305 = .12 and likewise the probability of disintegration is estimated to be the same.

As cargo behavior is completely absent from our data, assume that one-half the cargo will stay with the aircraft and one-half will exit through the fuselage breaks. In these accidents, the container will have an initial upper velocity limit of about 200 ft/sec so the linearized velocity distribution will be $(200 - U_p)/200$.

For the half that get thrown free, most of the energy will be absorbed in successive impacts with nonpuncturing materials, primarily ground, boulders, etc. The probability of squarely impacting a tree, jutting rock, or so forth is probably no larger than .1 so the total probability of impacting a potential puncturing agent with a velocity greater than U_p (assuming an accident has occurred) is .

$$P_{D2} = (.12)(.1)(.5)(1 - .005\ U_p)$$

$$= .0060 - 3 \times 10^{-5}\ U_p .$$

To determine the maximum puncture probability for "several breaks" accidents, certainly no more than one-half of the containers thrown from the aircraft will strike a potential puncturing source. In this case

$$P'_{D2} = (.12)(.5)(.5)(1 - .005\ U_p)$$

$$= .030 - 1.5 \times 10^{-4}\ U_p .$$

For the half of the containers that remain with the aircraft, it seems reasonable to let the expected probability of impacting a potential probe to increase to something on the order of .1 because of the fractured aircraft structural members. As an upper limit, a value of .3 is probably reasonable. Further, the maximum relative velocity between the aircraft and container will be less than the 200 ft/sec but certainly greater than the 40 ft/sec. Assuming this value is about 100 ft/sec, P_{D3} and P'_{D3} become

6/20

$$P_{D3} = (.12)(.5)(.1)(1 - .01\ U_p)$$

$$= .0060 - 6 \times 10^{-5}\ U_p .$$

and

$$P'_{D3} = (.12)(.5)(.3)(1 - .01\ U_p)$$

$$= .0180 - 1.8 \times 10^{-4}\ U_p .$$

Puncture Probability for Disintegration

For accidents which result in disintegration of the aircraft, the puncture probabilities are more dependent on impact angle than they are for the less severe accidents which most frequently occur at angles of 10 deg or less. Although our data indicates a relationship between velocity of impact and the fraction of impact angles below and above about 10 deg, there appears to be no strong correlation between v and α if α is over about 10 deg (accidents in which disintegration may be expected). As α approaches 90 deg, the probability of striking aircraft parts must approach 1 while at lower α the probability decreases. It has been assumed here this probability is linear, with α from 0 at 0 deg to 1 at 90 deg.

Exhibit 5, p2

From the data base, 12% of the accidents result in disintegration. Again, it seems reasonable to assume that if the cargo remains with the destroyed aircraft, the expected probability that this can result in puncture if the velocity is high enough is .1. The relevant velocity in this case is the normal velocity with the impacted surface, leading to

$$P_{D4} = (.12)(.1) \sum_{\alpha} P_{A/C}(\alpha)\, P_v(\alpha) ,$$

where

$P_{A/C}(\alpha)$ = the probability of hitting portions of the A/C

$P_v(\alpha)$ = the distribution of normal velocities .

Summing this over α leads to

$$P_{D4} = .0067 - 3 \times 10^{-6} U_p .$$

If the .1 value used above as the probability of puncture if the container and A/C parts impact is arbitrarily increased to .3, 6/20

$$P'_{D4} = .020 - 9 \times 10^{-6} U_p .$$

Note the low dependence on U_p. This indicates these accidents are so severe that the hardness of the container makes little difference.

If, in accidents where the aircraft disintegrates, the container is ejected from the vicinity of the aircraft without impact, a puncture threat is still present due to terrain protuberances, trees and so forth. In this case, the total velocity vector will be closer to the impact velocity and, since $U_p \ll v$, U_p will have essentially no influence on the puncture probability. The probability of disintegration is still .12 and the expected value of puncture if impact occurs is .1. The probability of not impacting A/C parts is $1 - P_{A/C}$ which, when summed over $10 \leq \alpha \leq 90$ leads to

$$P_{D5} = .0047 .$$

With a maximum puncture probability on impact of .3,

$$P'_{D5} = .0109 .$$

Gathering these probabilities together and summing gives the following table of values for P_D and P'_D. It should be noted that a qualification test of a 40-inch drop will only decrease P_D to .024 and P'_D to .081 so this hardly seems worthwhile.

Exhibit 5, p.3

yields a 107,520°F-min environment, which from Figure B-8 covers 89.5% of all fire accidents. There are an infinite number of comparable combinations.

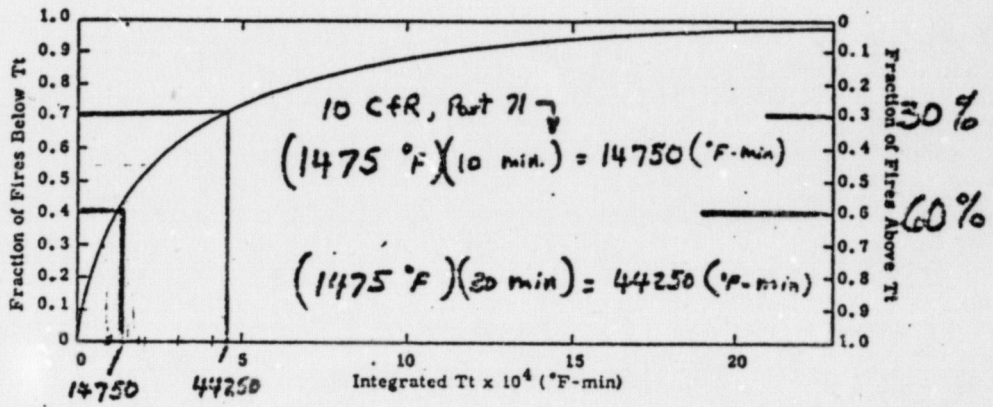


Figure B-8. Cumulative distribution of temperature-time produce for aircraft accident fire

In a similar manner the probability distribution of integrated incident flux on a unit area can be determined and the results of that calculation are shown in Figure B-9. As with Figure B-8 these results must be interpreted and used with caution since there are a infinite number of temperature-time combinations which can lead to the same integrated flux. Although the use of integrated flux incident on a container is a better defined description of the fire environment, the temperature-time product has been adopted here due to the ease and utility in deriving test criteria.

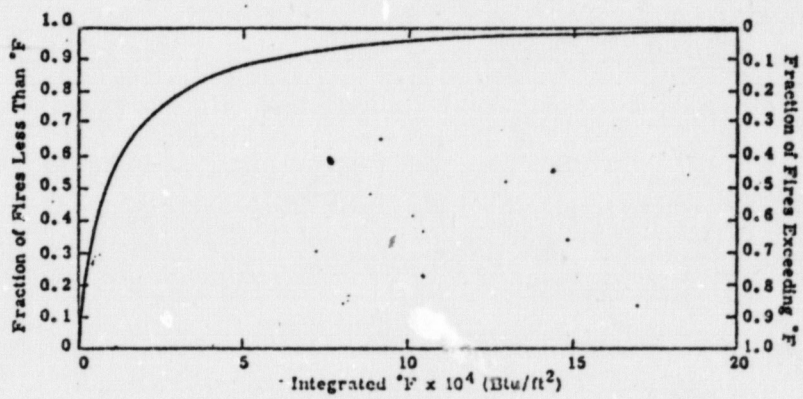


Figure B-9. Cumulative distribution of integrated incident heat flux from aircraft accident fire

Exhibit-6

734

Wind direction probabilities for the high-population density area were computed by the following method:

A Tri-State Regional Planning Commission Map (See Map 1), containing 1970 population densities per square mile, was obtained. The areas surrounding Kennedy Airport to a 10-15 mile radius with population densities of 10,000 per square mile or greater were outlined. This area describes an arc of 113°, or roughly 31% of a full circle. Then, probabilities for five various wind directions, in all four seasons, were computed from charts[1] contained in the Final Environmental Impact Statement for the Construction and Operation of an LNG Import Terminal at Staten Island New York (Federal Power Commission, July 1974). The five directions, covering arcs of 22.5% each, describe an arc of 113° conincident with the high population density area described above. The probability of winds blowing toward the high-population density area in the vicinity of Kennedy Airport is as follows:

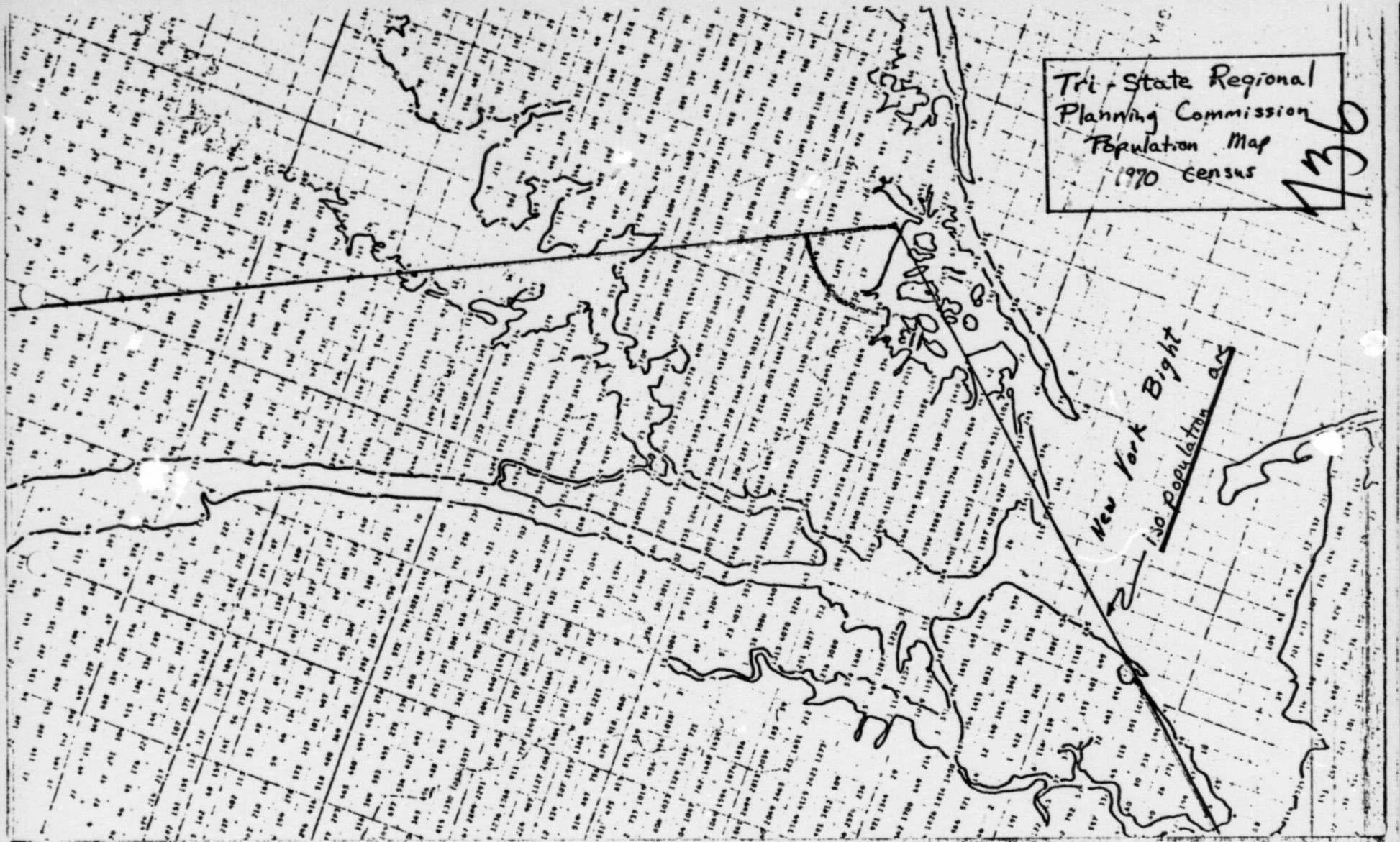
SEASON	WIND PROBABILITY		AVERAGE WIND (M.P.H.)*
	Day	Night	
Fall	39%	13%	11.5
Winter	17%	12%	13.5
Summer	63%	19%	10.7
Spring	46%	20%	13.0

* From National Weather Service figures

1. Maps I-IV, appended herein.

EXHIBIT "7"

735


Tri-State Regional
Planning Commission
Population Map
1970 census
New York Bight
150 Population

TASK III

WIND CLIMATOLOGY OF NEW YORK HARBOR

Climatological data was obtained for a number of stations of interest surrounding New York Harbor.

Part of the information is presented schematically in Figures 8, 9, 10 and 11 which are seasonal representations of the frequency with which winds can be expected to blow from various compass directions. These wind roses consist of a circle from which 16 lines emanate, one for each compass point. The length of each line is proportional to the frequency of the wind blowing from that direction. Thus, the line that points toward the north represents the frequency of winds that blow from the north toward the south. The 0300 Local Standard Time (LST) frequencies (night) are represented by the solid lines and the 1500 LST frequencies by the dashed lines. One chart is given for each of the four seasons, with winter defined as December, January and February, while spring covers March, April, and May, and so on.

Thus, for example, we see that La Guardia Field can expect - in winter - a wind from the westnorthwest direction at night about 16% of the time, and by day - from the same direction - about 20% of the time.

Looking at the tabulations of the speed data in Appendix B we see that these winter winds (from the same direction: westnorthwest) tend to blow - nearly half the time - at speeds of 11-15 knots, and average about 16 knots.

Still another way of presenting the information would be to state that in winter, a spillage of LNG on Staten Island would tend to project a vapor plume toward Manhattan with a 6% probability; toward Brooklyn and Queens with a 24% probability; toward New Jersey with a 34% probability and toward the open water with 36% probability.

737

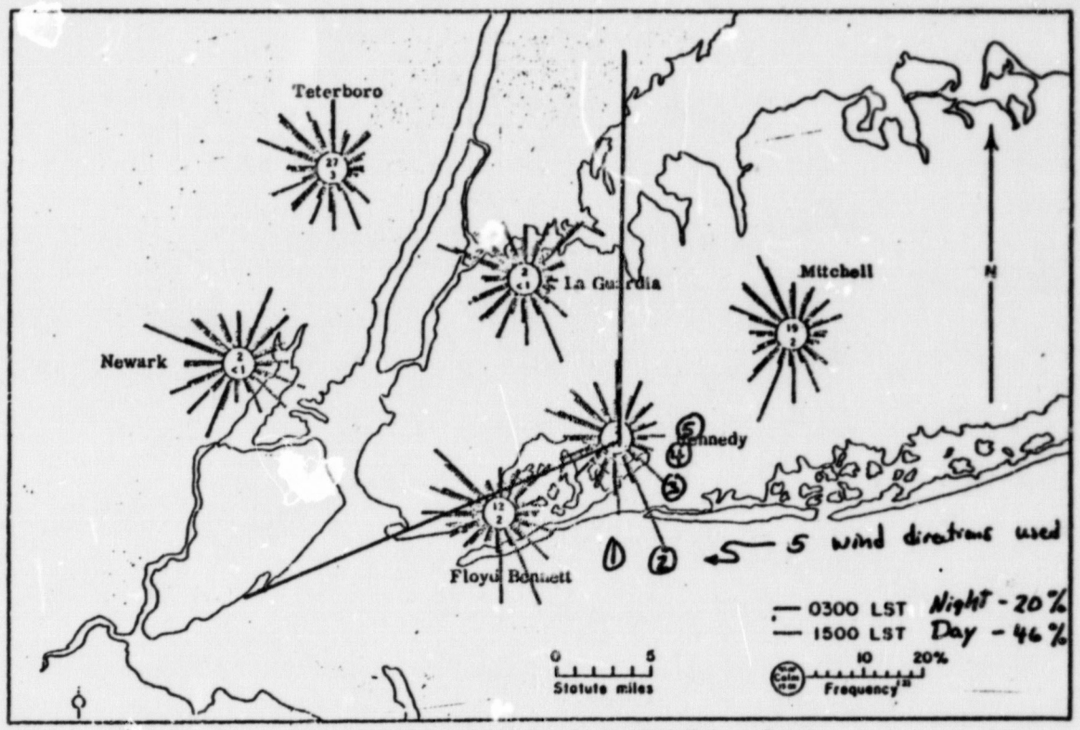


Figure 8 Climatological Wind Rose for New York Harbor in Spring

Chart 1

738

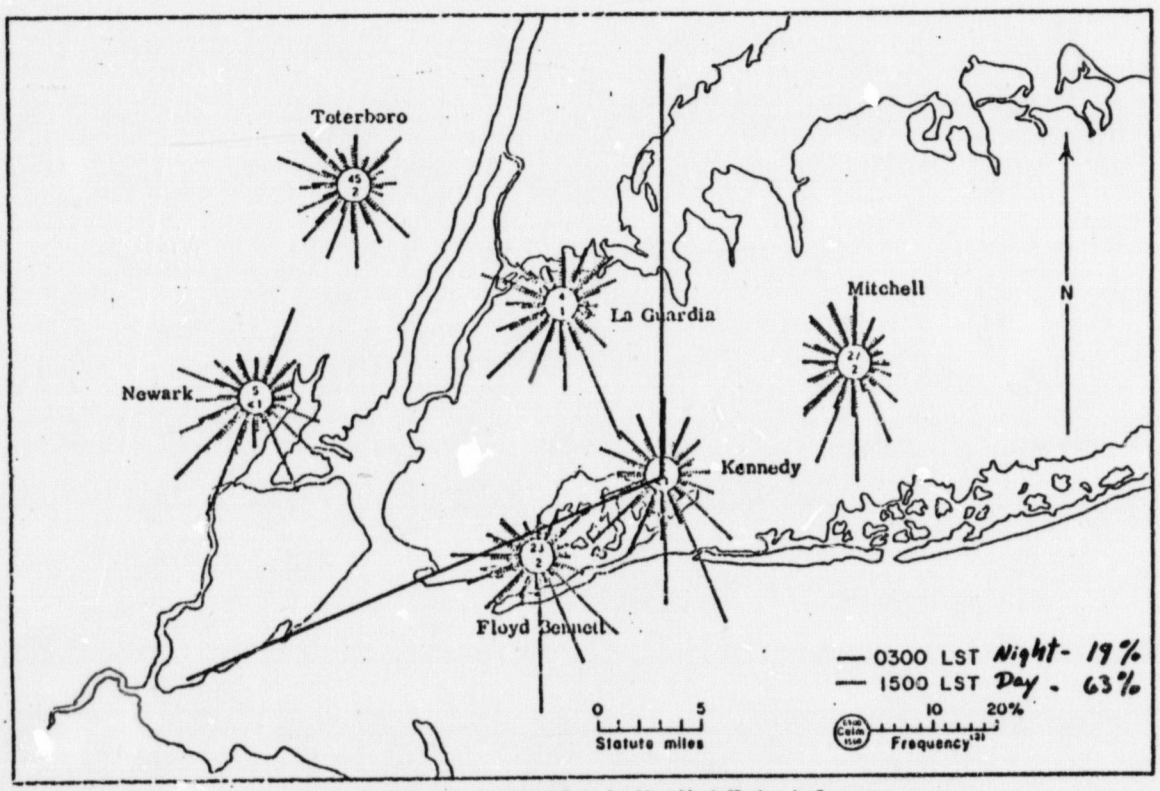


Figure 9 Climatological Wind Rose for New York Harbor in Summer .

Chart 2.

739

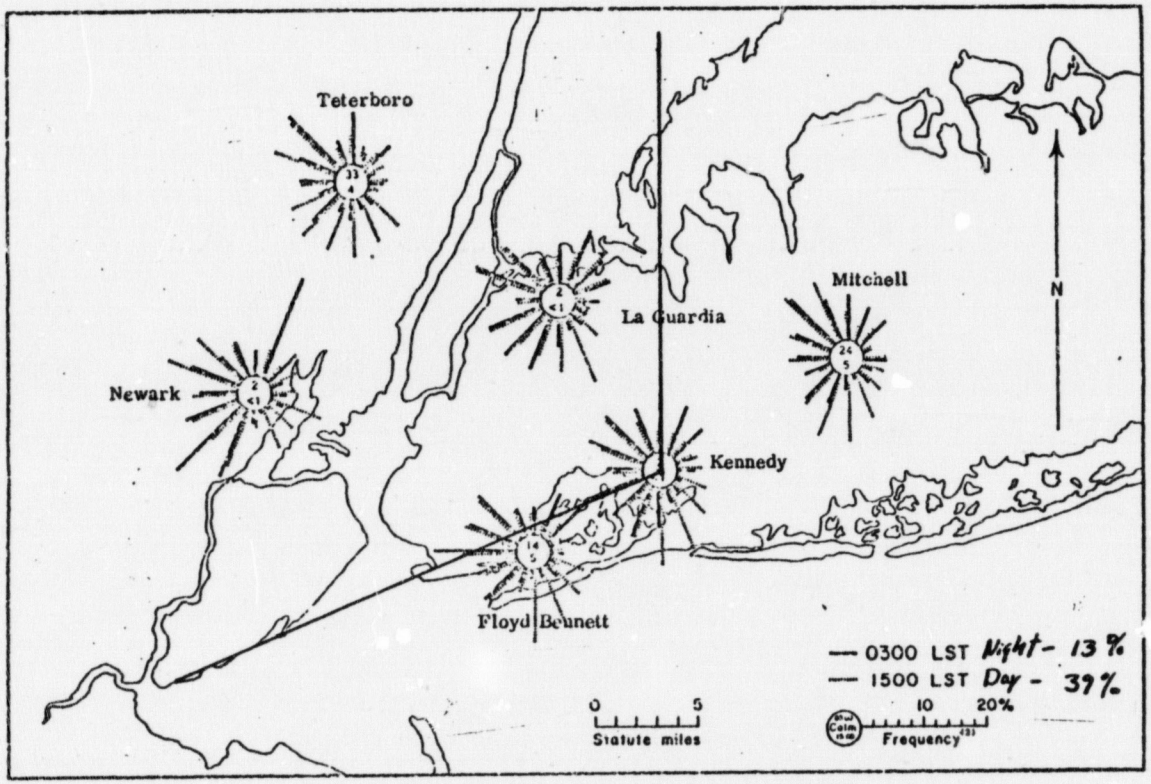


Figure 10 Climatological Wind Rose for New York Harbor in Fall

Chart 3

748

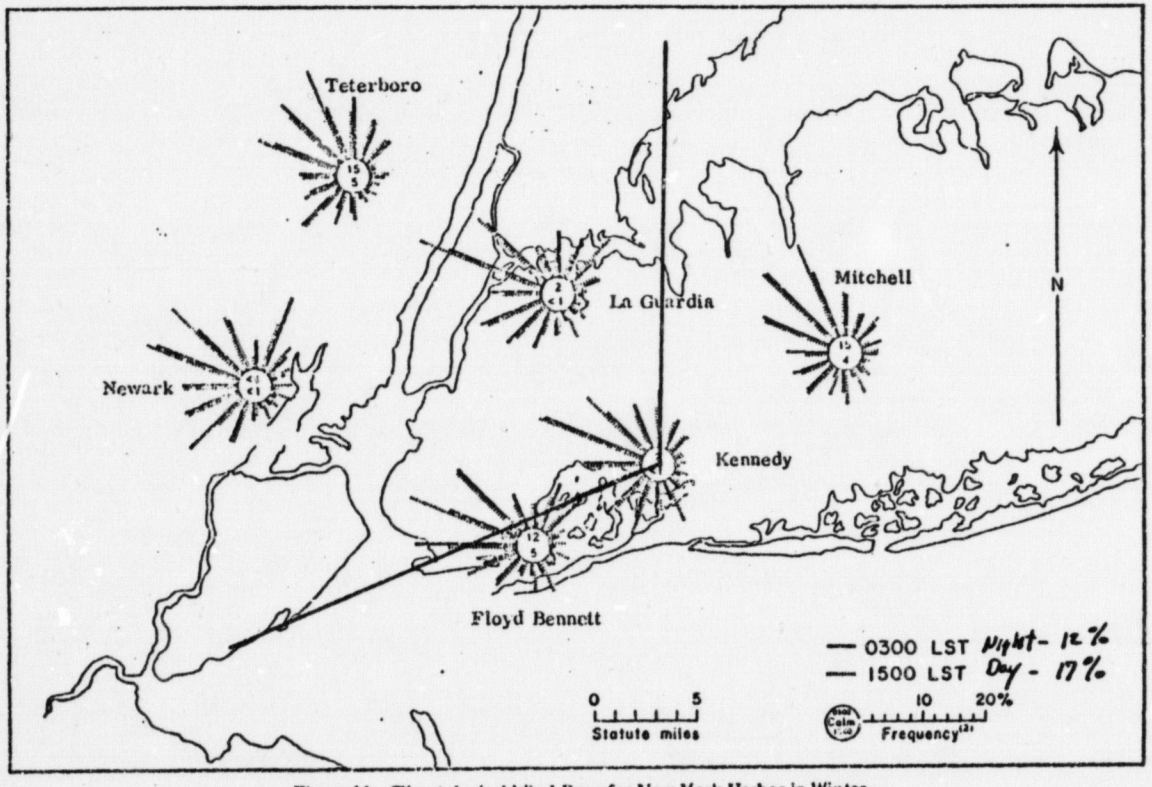
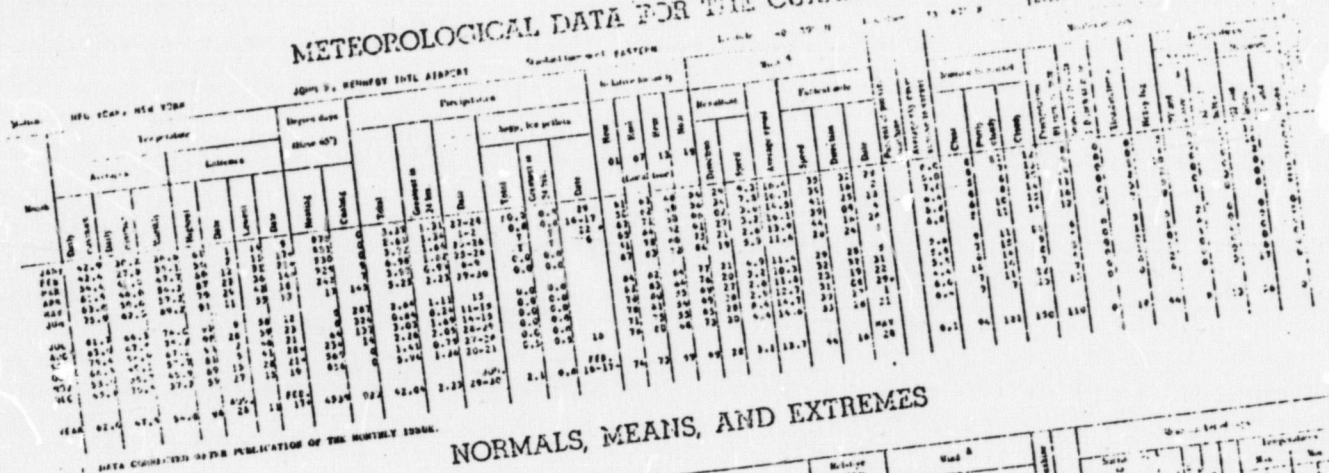


Figure 11 Climatological Wind Rose for New York Harbor in Winter

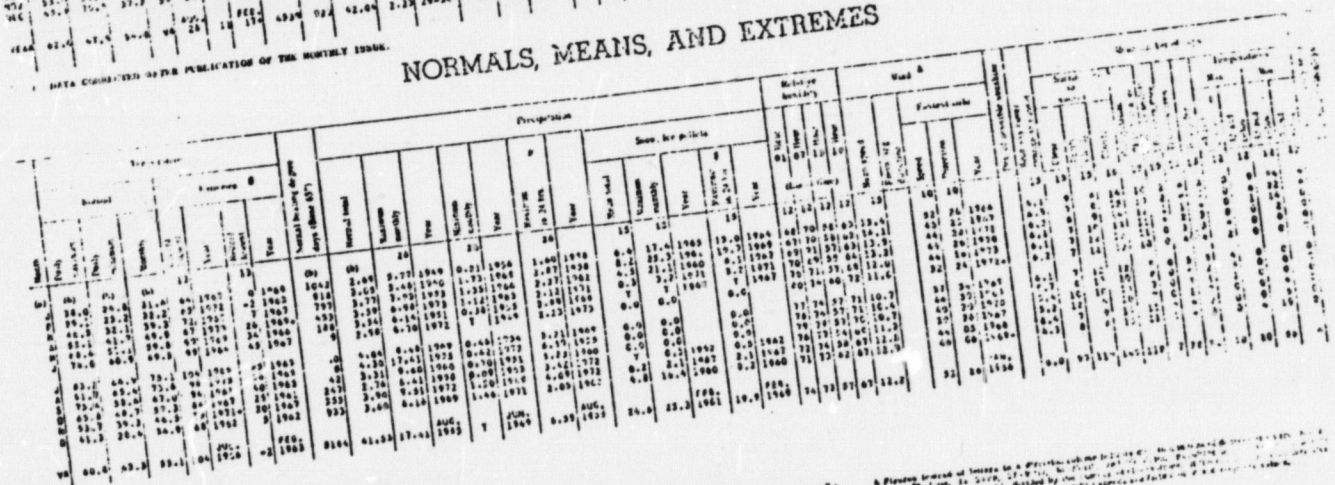
Chart 4

METEOROLOGICAL DATA FOR THE CURRENT [illegible]



DATA CORRECTED AFTER PUBLICATION OF THE MONTHLY ISSUE.

NORMALS, MEANS, AND EXTREMES



§ For the period June 1961 through the current year.

Unless otherwise indicated, dimensional units used in this bulletin are: temperature in degrees Fahrenheit; precipitation, including snowfall, in inches; and snowfall and snow depth in inches. Symbols used in place of numerical data are the same as those used in reports published by the National Weather Records Center. Certain fully descriptive terms are also used in the remarks section, such as "Heavy rain" for precipitation of 0.50 inch or more in a 24-hour period, "Dense fog" for visibility of 1/4 mile or less, and "Strong winds" for speeds of 30 m.p.h. or more.

Sky cover is expressed in tenths of the celestial dome covered by clouds or other obscuring phenomena as follows: 0 for clear, 1 for scattered, 2 for partly cloudy, 3 for cloudy, and 4 for obscured. The number of clear days is based on average cloudiness of 3.5 or less; partly cloudy days 3.6 to 7.5, and cloudy days 7.6 to 10.0.

Solar radiation data are the average of direct and diffuse radiation on a horizontal surface. The langley is a unit of energy equivalent to one gram calorie per square centimeter.

Degree days are computed from the mean temperature for the day. Heating degree days are the number of degrees that the mean temperature for the day is below 65° F. Cooling degree days are the number of degrees that the mean temperature for the day is above 65° F. Each day in a month or year is considered separately and only the applicable degree days are used. Annual (or seasonal) degree day totals are obtained by adding the daily values for the period. Monthly degree day totals may differ slightly from the sum of the daily values because the latter are rounded to the nearest whole degree before summing.

Average wind speeds are based on observations made at specified hours. Prevailing direction through 1963 was the most frequently reported direction based on the 8 points of the compass. Beginning with 1964, prevailing direction is the most frequently reported direction based on 36 points of the compass.

Peak gust is the highest instantaneous wind speed observed. Fastest mile is the highest speed recorded for any mile of wind passage. Fastest mile and peak gust data are not available for periods prior to 1951.

Sunshine is recorded in minutes. Percent of possible sunshine is the ratio of recorded sunshine to the maximum possible sunshine for the day, month, or year.

Sky cover, weather conditions, and wind are observed at specified hours. Clear days are those with an average sky cover of 3.5 tenths or less; partly cloudy days are those with average sky cover between 3.6 and 7.5 tenths; cloudy days are those with average sky cover of 7.6 tenths or more. Precipitation, thunderstorms, and heavy fog are entered for the day of occurrence. Dense fog is reported when visibility is 1/4 mile or less.

Temperatures are in degrees Fahrenheit. Extremes are the highest and lowest temperatures recorded during the period of record. Mean temperatures are computed by averaging the daily maximum and minimum temperatures. Monthly and annual means are computed from the daily means.

Precipitation totals are liquid water equivalents. Snowfall is measured daily and is entered for the day on which it occurs. Monthly and annual totals are the sums of the daily values. Snow depth is the amount on the ground at observation time.

Wind direction is the direction from which the wind is blowing. Wind speeds are in miles per hour. Resultant wind speed and direction are computed from hourly observations of direction and speed. Resultant wind direction is the direction from which the resultant wind is blowing.

Relative humidity is the ratio of the amount of moisture in the air to the amount it would hold if saturated. Humidity is measured at specified hours.

Station pressure is the pressure of the atmosphere at the station. Sea level pressure is station pressure corrected to mean sea level.

Data are based on observations made at the Weather Bureau Office at the Airport, Kenmore Square, Boston, Mass., and at the Blue Hill Observatory, Milton, Mass.

Normals are averages for the 30-year period 1931-1960.

Records are for the period of record, based on January data, unless otherwise noted. Earlier or later extremes may exist for periods of less than full record.

T — Trace, an amount too small to measure.

M — Missing data.

— — Data not applicable.

* — Also occurred on earlier date(s).

§ Greatest monthly or annual precipitation in any consecutive 24-hour period.

‡ Greatest snowfall in any consecutive 24-hour period.

† Prevailing direction through 1963 was the most frequently reported direction based on the 8 points of the compass. Beginning with 1964, prevailing direction is the most frequently reported direction based on 36 points of the compass.

§ Greatest snowfall in any consecutive 24-hour period.

‡ Greatest snow depth on any day.

† Prevailing direction through 1963 was the most frequently reported direction based on the 8 points of the compass. Beginning with 1964, prevailing direction is the most frequently reported direction based on 36 points of the compass.

§ Greatest snowfall in any consecutive 24-hour period.

‡ Greatest snow depth on any day through March 1964.

† Greatest on-hour day August 1936 through June 1937.

CFR/M

Annex

1 St. Andrew's Plaza

June 10, 1975

BY HAND

Honorable William C. Conner
United States District Judge
United States Court House
Foley Square
New York, New York 10007

Re: The State of New York v. The Nuclear Regulatory Commission, et al.
75 Civ. 2121 (WCC)

Dear Judge Conner:

In prior representations we made to you, it was stated that the Nuclear Regulatory Commission knew of no significant shipments of plutonium through J. F. Kennedy Airport within the future. To avoid any possible confusion, we are writing to make clear that this representation applied only to shipments by NRC licensees and not to shipments made by the Energy Research and Development Administration, which does not require a license from the NRC.

Thus, we have been informed that ERDA intends to ship less than 50 milligrams (1/20th of a gram) of plutonium within the near future to Italy via J. F. Kennedy Airport. The plutonium is being sent pursuant to a contract with Italy and will be used in a neutron flux monitor, a device used in nuclear reactors.

Very truly yours,

PAUL J. CURRAN
United States Attorney

By: _____
CHARLES FRANKLIN RICHTER
Assistant United States Attorney
Telephone No.: (212) 791-1977

743

CFR:m

BY HAND

cc: John F. Shea, III, Esq.
Department of Law
Environmental Protection Bureau
Two World Trade Center
New York, New York 10047

488-7562

June 24, 1975

Honorable William C. Conner
United States District Judge
Southern District of New York
United States Courthouse
Foley Square
New York, New York 10007

Re: The State of New York v. The Nuclear Regulatory Commission, et al.
75 Civ 2121 (WCC)

Dear Judge Conner:

Enclosed for your convenience are copies of certain materials cited in the State's Memorandum of Law in Support of the Motion for a Preliminary Injunction:

1) NRC Notice Soliciting Comment on Deferral of Licensing Actions - Generic Environmental Statement on Mixed Oxide Fuels (recycle of plutonium) 40 Fed. Reg. 20142 (May 8, 1975).

2) Comments of the United States Environmental Protection Agency excerpted from the Final Environmental Statement - Mixed Oxide Fabrication Plant, Exxon Nuclear Company, Docket No. 70-1257, June 1974, United States Atomic Energy Commission.

Respectfully yours,

LOUIS J. LEFKOWITZ
Attorney General
By

JPS:rab
Enc.

JOHN F. SHEA, III
Assistant Attorney General

Final

environmental statement

related to operation of

MIXED OXIDE FABRICATION PLANT

EXXON NUCLEAR COMPANY

DOCKET NO. 70-1257

JUNE 1974

UNITED STATES ATOMIC ENERGY COMMISSION
DIRECTORATE OF LICENSING
FUELS AND MATERIALS

746

FINAL ENVIRONMENTAL STATEMENT

BY

FUELS AND MATERIALS

DIRECTORATE OF LICENSING

U.S. ATOMIC ENERGY COMMISSION

RELATED TO THE

EXXON NUCLEAR COMPANY

MIXED OXIDE FABRICATION PLANT

DOCKET NO. 70-1257

JUNE 1974

X. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

The Advisory Council on Historic Preservation
The City of Richland Ecology Commission
The Department of Health, Education, and Welfare
The Department of the Interior
The Environmental Protection Agency
The State of Washington Department of Game

All letters received as a result of request for comment are reproduced in Appendix E. The issues raised in these letters are addressed in the following listing of comments and responses.

Agency: Environmental Protection Agency

Comment:

The discussion of the steel storage buildings in the draft statement, states that 5-gallon cans of low enrichment uranium and packaged uranium contaminated materials are routinely stored in these buildings (page III-7); however, there is no evaluation of any potential hazards associated with sucl storage. The final statement should address this subject and assess the potential environmental effects of severe natural disasters (such as a DBA tornado) on these storage buildings and the containers of uranium.

Response:

The steel storage buildings in question are considered part of the Uranium Oxide Fuel Plant, and are used to store slightly enriched uranium and packaged uranium - contaminated materials. The discussion of the response of the UO_2 building to Design Basis Accidents involving natural phenomena discussed on pp. VI-13 to VI-15 of the Final Environmental Statement related to operation of the Uranium Oxide Fuel Plant also applies to these buildings. In summary, the design was based on the Uniform Building Code, and the design bases included a seismic acceleration of 0.17 g, a steady wind load of 100 mph, and consideration of a 1000-year flood level in the Columbia River. There would be no significant release of radioactive materials under these conditions.

Comment:

The vegetation sampling and analysis program appears to be adequately planned and executed; however, the program for soil sample analysis appears to be incomplete. It would seem more prudent to analyze soil from stations 2 and 4 on the same frequency as station 1, and the balance of the stations on some regular frequency. The final statement should address this matter, indicating the rationale behind the sample analysis frequency.

Response:

The environmental monitoring program is designed to detect and evaluate concentrations of radioisotopes resulting from chronic releases from the MOFP to the environment. The primary indicator of the magnitude of chronic release is the plant effluent sampling system, which will

detect the level of such releases on a weekly basis. Backing up this system is the program for sampling and analyzing vegetation and soil in the local environment on a monthly and quarterly basis. Since this program is designed to detect long-term buildups of radionuclides, the samples from the station located downwind in the most probable wind direction are analyzed monthly (vegetation) and quarterly (soil). Samples from the remaining stations are analyzed quarterly (vegetation) and the soil samples are stored for future analyses as deemed necessary. This program is designed to provide sufficient numbers of samples to permit a quantitative assessment of the buildup of plutonium in the environment, if any, and to detect the onset of radioisotope buildup in time to initiate a more extensive investigative analysis program.

Comment:

The final statement should describe any automatic features of the stack monitoring system, such as alarms and automatic shutoffs, which limit the amount of activity which could be released before some corrective action is taken. Factors such as the length of time the operating limit can be exceeded without detection, the maximum amount which could be released, and the subsequent individual and population dose commitments resultant from such a release should be discussed.

Response:

No mechanisms have been identified whereby the efficiency of the HEPA filter system under normal operation could be suddenly and significantly changed. It has been concluded that weekly analysis of the samples taken downstream of each HEPA filter bank provides an adequate means of detecting deterioration and impending breakthrough of the HEPA filters - particularly since three filters in series are provided. The pressure drop across each HEPA filter bank is read and recorded daily as a means of detecting significant plugging, blinding, or breaching of the filters. In addition, as stated in Section III.C.3.a, "All main duct HEPA filters are provided with differential pressure indicators and switches that automatically shut down the ventilation systems on a sudden pressure change."

However, as an additional safeguard to limit abnormal releases, the applicant has agreed to install continuous air monitoring in the ventilation ducts upstream of the final filter banks. Installation and operation of a continuous air monitoring system is a condition for protection of the environment and is described in Item 7, p. iv, "Summary of Environmental Statement", in this EIS. The system described will alarm upon sensing counts equivalent to 10^{-9} μCi/cc for an hour. Since aerosol of this concentration must pass through tested final

filters, the resultant stack effluent would have a concentration about one-half of 10 CFR 20 limits for insoluble ^{239}Pu in unrestricted areas. Therefore, system activation and subsequent corrective action will be adequate to limit such releases to an insignificant fractional component of normal releases discussed in Section III.C.3 of this EIS.

Comment:

The final statement should also include an analysis of the consequences of the discharge and dispersal of long-lived radionuclides into the general environment. By virtue of the long persistence of these materials these consequences may extend over many generations and, in this respect, these discharges can represent irreversible public health commitments. The recently published "Environmental Radiation Dose Commitment: An Application to the Nuclear Power Industry" (EPA-520/4-73-002) presents general concepts for calculating the cumulative consequences of the release of longer lived radionuclides to the environment. This analysis should include the consequences to all individuals over the entire time period the material persists in the environment. This cost should be included with other environmental costs in the cost-benefit analysis.

Response:

Table III.C.1 shows an estimated radionuclide release rate of 5.22×10^{-6} μCi α/year. For the 20 year lifetime of the plant operating at design capacity, this results in release of about 10^{-4} μCi α that is assumed to eventually fall to earth. The above quantity of material was assumed to be distributed uniformly over some area and resuspended to form an air concentration 10^{-8} times the surface density, which is in agreement with EPA-520/4-73-002, "Environmental Radiation Dose Commitment: An Application to the Nuclear Power Industry." Using the ICRP-II Model and a time period consistent with EPA-520/4-73-002 (Page 7), the 100 year dose to the lung from continuous inhalation of insoluble ^{239}Pu at the calculated air concentration was determined. The calculated dose commitment was determined using an estimated year 2070 population (40 year doubling time) for the area within a 50-mile radius of the MOFP. The resultant "environmental dose commitment" is, thus, estimated as 6.5×10^{-3} man-rem (lung).

The population density in the area within 50 miles of the MOFP is about 23 people/mi.^{2}. If uniform distribution of actinide is assumed over the surface considered, the estimated "environmental dose commitment" from fallout of radioactive aerosol from the MOFP is a close approximation for the States of Washington, Oregon, and Idaho (∿ 26 people/mi.^{2}); the states west of the Mississippi River (∿ 34 people/mi.^{2}); North America (∿ 25 people/mi.^{2}); and the world (∿ 20 people/mi.^{2}).

The "environmental dose commitment" to the lung of man (6.5×10^{-3} man-rem) was added to the cost section, Human Health, of Table IX.A.1, Benefit-Cost Summary.

Comment:

It is unclear in the draft statement, as to what levels the low-level waste will be contaminated with plutonium and what methods of disposal will be utilized. Since the disposal of plutonium bearing wastes represents a long-term commitment, the AEC should consider requirements for the interim storage and retrievability of these wastes. The final statement should indicate what commitment, if any, is being made relative to storage of low-level plutonium bearing waste in a form which will facilitate retrieval at a later date.

Response:

The treatment and disposal of all plutonium-contaminated wastes, including low-level wastes, are discussed in response to a comment by the U.S. Department of Interior shown on page X-23 of this EIS.

Comment:

In order to adequately evaluate the potential impact of this facility's operations, the details of the emergency response plans must be reviewed. The draft statement, however, did not contain this information. The final statement should include the emergency response plan.

Response:

The Exxon Nuclear Company Site Emergency Plan is a condition of the applicant's special nuclear material license and a subject of periodic inspection by the AEC. The Emergency Plan's purpose is to provide guidance and action plans for the protection of the health and safety of the general public, Exxon Nuclear employees, and the limitation of damage to equipment, facilities, and property in the event of emergency situations, such as accidental criticality, fire, explosion, sabotage, and natural phenomena. Execution of this plan is intended to mitigate the consequences of accidents discussed in this EIS.

The elements of the plan include:

a) The Exxon organization for coping with emergencies, including specific authorities, responsibilities, and duties;

b) Means of notification, both persons assigned to the emergency organization and appropriate State and Federal agencies with responsibilities for coping with emergencies;

c) Written identification by position or function of other persons with special qualifications for coping with emergency conditions, both Exxon Nuclear employees and others;

d) Measures to be taken to protect health and safety within and outside the plant boundary and criteria to determine when such measures are necessary;

e) Expected response of offsite agencies;

f) Means for determining the magnitude of release of radioactive material, including criteria for notification and participation of local and State agencies and the AEC and other Federal agencies;

g) Plant features provided to assure capability of plant evacuation and safe reentry;

h) Procedures for and agreements with local, State and Federal officials and agencies for early warning of the public used for public evacuation or other protective measures should such warning and action be necessary;

i) Provisions for maintaining up-to-date: 1) The organization for coping with emergencies, 2) the procedures for use in emergencies, and 3) the lists of persons with special qualifications for coping with emergency conditions;

j) Emergency first aid and personnel decontamination facilities, including: 1) equipment at the site for personnel monitoring; 2) facilities and supplies at the site for decontamination of personnel; 3) facilities and medical supplies at the site for appropriate emergency first aid treatment; 4) arrangements for the services of a physician and other medical personnel qualified to handle radiation emergencies; and 5) arrangements for transportation of injured or contaminated individuals to treatment facilities outside the site boundary;

k) Arrangements for treatment of individuals at treatment facilities outside the site boundary;

l) Provisions for training employees who are assigned specific authority and responsibility in the event of an emergency and of other persons whose assistance may be needed in the event of a radiation emergency;

m) Provisions for testing, by periodic drills, of radiation emergency plans to assure that employees are familiar with their specific duties, and provisions for participation in the drills by other persons whose assistance may be needed in the event of a radiation emergency;

n) Criteria to be used to determine when, following an accident, reentry of the facility is appropriate or when operation should be continued;

o) Implementing procedures.

Comment:

In considering the transportation of plutonium to the Exxon facility, the draft statement did not discuss the packaging to be used. It was stated, however, that the packaging would be AEC licensed and DOT approved. Therefore, it is reasonable to assume that the packaging will be similar to that currently approved by DOT in 49 CFR 178, with proposed amendments dated October 25, 1973, and under special permits issued by DOT.

Response:

The standards and regulations governing the packaging and shipping of radioactive materials are set forth in the regulations of the AEC (10 CFR Part 71) and the Department of Transportation (DOT) (49 CFR Parts 170-179). It may be expected that the design of packaging currently in use or the standards and regulations will change in the future. Thy packaging to be used for the transportation of plutonium will be in accordance with standards and regulations in effect at that time, thus, special permits will not be required.

Comment:

Three such packages were tested by Sandia Laboratories (Report No. SC-DR-720597, September 1972) and the lids were popped off of one side of each container after impact. If a shipment of plutonium were in an accident involving a fire, it is likely that the inner containers of some of the packages would be subjected to high temperatures which could result in the dispersal of the material into the environment upon the failure of the inner container.

While these tests were more demanding than those specified in the draft statement (130 fps vs. 45 fps for impact), it is suggested they may be more indicative of actual accident conditions for these smaller packages than the tests specified in the draft statement. We believe that it would be prudent to adopt more stringent standards for the design and fabrication of these types of packaging and to require comprehensive performance tests on each design, at these more stringent levels, prior to their wide-scale use by industry.

Response:

The tests carried out by the Sandia Corporation, Albuquerque, New Mexico, were on packaging designed to meet the current standards. The packaging used in tests were representative of those currently used for the shipment of plutonium. The tests included exposure to severe impact, fire and other environmental conditions in excess of those required by applicable regulations. We believe the results of these tests provide confidence that the packaging designed to the current standards will maintain their integrity under actual transport conditions.

Comment:

The final statement should discuss the rationale to be used in selecting the accident criteria for the shipping containers, and describe how compliance will be insured.

Response:

The packaging standards set forth in the regulations have had a long history of development and application both in the United States and internationally. The standards were first published by the International Atomic Energy Agency (IAEA) in 1964. There was extensive participation by U.S. representatives and representatives of other leading countries in the atomic energy field in developing the IAEA regulations. Subsequent to the initially published standards, there have been a number of modifications of the standards based on more extensive information from operating experience and research and development programs. The IAEA standards have been adopted in many international and national transportation regulations and have served as a basis for the regulatory standards in the United States. The development included an analysis of normal and accident conditions in transport and nearly 20 years of experience in shipping many types of radioactive materials.

The principal responsibility for assuring that the design, fabrication, and use of a package for transporting radioactive materials meets the standards rests with the shipper. However, the shipper must not only determine that his package design will meet the regulatory standards, but must also demonstrate that fact to the AEC. The

applicant requesting approval of a package must prepare a safety analysis, in which he analyzes the safety features of the design, reports the results of prototype tests, and describes his quality assurance program for construction, use and maintenance of the package built to the design.

The AEC makes a thorough, independent evaluation of the design and data submitted by the designer in support of his request for package approval. Only after satisfying itself that the design meets all of the standards, and that the quality assurance program is adequate, does the AEC issue approval.

The evaluation of the potential environmental impact from the transportation of radioactive materials is not limited to an engineering assessment that the package design will meet standards. The evaluation is also supported by operating experience and data on accident statistics.

Comment:

It has been our position that environmental statements for sites containing more than one nuclear facility, should contain an assessment of the total environmental impact from all operations at the site. In the draft statement for Exxon's Uranium Oxide Fuel Plant, published by the AEC in May 1973, it was stated that, "the environmental statement for the mixed oxide operations will consider the combined radiological effects of all of the Exxon operations on the site." The draft statement for the mixed-oxide plant does not appear to contain such a combined evaluation. It is most important that the final statement for the Exxon Mixed Oxide Fabrication Plant assess the total impact of all nuclear facilities at this site.

Response:

The draft statement contained a discussion of the annual airborne release of enriched uranium from the uranium oxide plant on page V-5. Included in that discussion was an observation that the effect of that 1.5 μCi/yr release was negligible when compared with the small (144 μCi/yr) release of plutonium activity from the MOFP. Additional address to this topic is provided in response to a comment by the Department of the Interior on page X-19 of this impact statement.

Comment:

Appendix C, "Considerations Relating to the Estimation of HEPA Filter Efficiencies," is a valuable addition to the draft statement. However,

the work reported by Hetland and Russell at the 12th AEC Air Cleaning Conference is not included (N. Hetland and J. L. Russell, Jr., "Adequacy of Ventilation Exhaust Filtering System for New Plutonium Facilities" Proceedings of the 12th AEC Air Cleaning Conference, Oak Ridge, Tennessee, 28-31 August, 1972. CONF-720823, January 1973). Their findings indicate that the first and second HEPA filters in series removed 99.999% of the plutonium while the third HEPA in series only removed 94%. These results were based on HEPA filters used under actual operating conditions and should be considered in Appendix C.

Response:

The staff is aware of the above referenced work of Hetland and Russell that presents data on HEPA filter efficiency in an operating ventilation system. Ettinger's conclusion, as stated in Appendix C, that 99.97 percent efficiency is the poorest performance to be expected from carefully installed and tested filters is not refuted by the subject Hetland and Russell paper. In fact that conclusion may be supported in that it is possible, if not probatle, that the low (94%) efficiency for the third bank of filters is due to improper filter mounting and/or inadequate sealing. For this reason the Hetland and Russell paper is not felt to be an important factor in the considerations presented in Appendix C.

Comment:

EPA, in our comments on the draft EIS for the Exxon Nuclear Uranium Oxide Fuel Plant, dated May 29, 1973, questioned the rationale for discharge of cooling water (up to 2,605,000 ℓ/day (688,000 gpd)) to the Richland waste facility. While the EPA does not anticipate that the facility as proposed would result in any significant adverse impact to the aquatic environment, we recommend that the applicant consider combining discharge from the Mixed Oxide Fabrication Plant with that of Uranium Oxide Fuel Plant if alternative disposal is determined to be appropriate.

Response:

The Applicant is currently considering alternate methods of cooling water disposition. Combining the cooling water discharge from the Mixed Oxide Fabrication Plant with that from the Uranium Oxide Fuel Plant is being considered as part of this study, which includes an investigation of alternatives for handling its used cooling water. The alternatives include: 1) recycle, 2) irrigation, and 3) groundwater recharge via seepage ponds. A separate environmental report

will be submitted, probably together with the one describing the ultimate waste treatment facility prior to any change in cooling water discharge method. The only alternate currently licensed is discharge to the city's system.

It should be noted that the upper volume of 688,400 ± 10% gallons per day of cooling water discharge has not been realized; the maximum volume of liquid wastes discharged to the municipal sewerage system to date has been 155,000 gallons in any 24-hour period.

Comment:

In Table II.D.1 on page III-21 the number for average uranium concentration in the retention tank is listed as "<1.1 ppm," the correct number should probably read, "<0.1ppm."

Response:

Table III.D.1 on page III-21 was corrected as indicated above.

Comment:

On page V-8, paragraph 4, there appear to be two misprints. The units given as, "µCCi/cm," should be corrected to, "µCi/cm" and the value "2.47 x 10^{-3}Oc Pu µCi/g soil," should probably read, "2.47 x 10^{-8} µCi Pu/g soil."

Response:

The two misprints referred to above have been corrected in this EIS.

Comment:

The cost of site restoration is listed on page VII-1 as $500,000; however, pages VIII-1 and IX-3 show a cost of $2,500,000 for similar activities. This apparent inconsistency should be corrected in the final statement.

Response:

The value on page VII-1 has been corrected to read $2,500,000.

Comment:

The reference on page IX-4 to Table B-1 may easily be misinterpreted to refer to Table IX.B.1. This could be rectified by giving the page number of the table.

Response:

The reference to Table B-1 was clarified by identifying the Appendix in which it is contained.

Comment:

The draft statement notes that, although no moisture separators are provided to protect the final filters against water "logging" from the ventilation deluge system, deluge tests of ten minutes in duration produced no observable physical effects on the filters. The final statement should contain information on tests of filter efficiency under conditions of deluge system operation.

Response:

Contrary to earlier indications, HEPA filters were not in place in the filter housing at the time the deluge system was tested. During the subject test, the employee stood in a position between the deluge nozzle and the filter support frames. With the ventilation system and the deluge system operating the employee reported that he felt no droplets of moisture during the test. Upon completion of the test, the employee indicated that he felt damp, but his clothes were not visibly wet. Therefore, it is reasonable to assume that HEPA filters would be exposed to 100 percent humidity during operation of deluge systems. However, efficiency ratings (e.g., $\geq$ 99.97% removal of 0.3 μm particles) are verified for 100 percent humidity conditions.

Related to this concern, is undocumented experience with HEPA filter operation during deluge system operation in 300 Area (Hanford Reservation) facilities. The 300 Area facilities' deluge system and HEPA filter arrangements were similar to those of Exxon Nuclear's. Differential pressure readings across HEPA filters were observed during and following the operation of the deluge systems, and it was observed that there were no significant increases in Δp. Also, following such occurrences, there were no apparent deleterious effects on the HEPA filters.

Section V.E.3.b of the DES has been modified to reflect these considerations.

Agency: State of Washington-Department of Game

Comment:

We do feel that secondary wildlife impact may occur as a result of urban developments and installation of water, sewers, and other utilities attracted by this project. This impact was not adequately discussed in the report.

Response:

To address this comment the following statement was added to Page V-7 of the FES.

> "The total employment (direct and secondary) estimated to result from the MOFP operations is 165 (see Table IX.A.1) which is small compared to the urban population of the Tri-Cities area of ∿100,000. Thus, the urban development and associated effects brought about by the Exxon facility should cause relatively small incremental impact on the wildlife in the area. As is pointed out later in Section IX.7, the employment by Exxon Nuclear replaces jobs lost as a result of curtailed plutonium production at Hanford; and thus the net population and urban effect is considerably smaller than would be the case otherwise."

elas

UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF NEW YORK

- -x

THE STATE OF NEW YORK,

Plaintiff,

-against- 75 Civ 2121

THE NEW REGULATORY COMMISSIONER, et al.,

Defendants.

- -x

B e f o r e:

HONORABLE WILLIAM C. CONNER,

District Judge.

New York, N. Y.
July 3, 1975 - 10:30 a.m.

A p p e a r a n c e s:

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SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y.

MR. ZEDROSSER: Your Honor, the Court please, we do have a couple of housekeeping matters. I now hand up an errata sheet for the brief that we handed in.

THE COURT: It is somewhat shorter than the brief.

MR. ZEDROSSER: There is nothing of any great import on that except for the item on page 20, line 3. This relates to the number of SNM shipments by air by ERDA within a recent six-month period and it should be 400 instead of 40.

Mr. Shea also has another housekeeping matter relating to Dr. Gofman's affidavit.

MR. SHEA: We recently received a letter from Dr. Gofman concerning the affidavit submitted on dispersion and toxicity. He found an arithmetical error in a certain page on an exhibit to his affidavit and the error was carried over into the text. The bottom line of the error is that in one of the hypothetical dispersion examples that is used in his affidavit, 6.3 million persons would be killed instead of 7.4 million persons. The error deals with toxicity and nonsmokers.

THE COURT: What page is that?

MR. SHEA: He found an error on page 23 of the report annexed as Exhibit B to his previous affidavit.

He will be supplying us with a new affidavit shortly. I can hand up a preliminary copy of his affidavit if the Court wishes, or we can wait until Dr. Gofman supplies us with his final.

MR. ZEDROSSER: Your Honor, moving from housekeeping, I guess if the Court has had the chance in the time allotted to read our submissions including our brief --

THE COURT: I have quickly read the briefs. I have not read all of the affidavits.

MR. ZEDROSSER: Even just on the briefs, I think it was emphasized there, I hope clearly, and I wish to emphasize anew that it is our position that without even reaching any disputed facts, notwithstanding the affidavits that have been submitted, that it is our position that the Court should grant a preliminary injunction. Obviously, if it did not reach such disputed facts, then no evidentiary hearing would be required. If the Court please, I can go into that at this point.

THE COURT: Well, have you filed a statement of these undisputed facts which would be comparable to our statement under rule 9-G?

MR. ZEDROSSER: We have in our memorandum of law intended to do essentially that. In our argument number 3,

I can cue it into precise pages. It would be pages 19 through 23. That is precisely what that purports to be.

THE COURT: All right. It seems to me that most of the cases you rely on differ substantially in the facts from the situation we have at bar in that in most of those cases an injunction is sought to prevent a change in an existing status quo. For example, by constructing a post office or by constructing a superhighway or some other structures, that is going to substantially change an existing situation.

Here we have a situation which has continued for twenty-five years. Now we have the enacting of an environmental protection act which is passed some twenty years after that activity starts. What you want to do with the present suit is to change the status quo instead of preserving it. You want me to enjoin something that has gone on safely for twenty-five years because of an intervening environmental protection act; and I should think that the Court should do that only on an extremely clear showing that there is a high probability of injury. I don't agree with the defendants' argument that you have to show the certainty of injury. If that were true, you couldn't enjoin somebody from firing a machine gun in Times Square because it's possible that he might not hit

anyone and he might not even break any glass windows. Not likely, but possible.

But on the basis of what I have seen and particularly the fact that for twenty-five years there has been no injury and in further view of the fact that the injunction you seek would substantially interfere with existing patterns of transportation of special material for beneficial purposes, including such things as Pacemakers and medical research, I would be extremely reluctant to tamper with that and would do so only if I were thoroughly convinced that there was a very high probability of injury if I failed to grant the injunction.

MR. ZEDROSSER: Your Honor, in speaking of the twenty-five year situation, I am afraid that that may be a reflection of the view the government is trying to put forward here, which is dealing with this as a "program." We say that these licenses and shipments themselves are major federal actions and we have cited cases for that proposition. Dams have been built for probably more than twenty-five years. That does not stop the applicability of ~~need~~ NEPA for a specific project nor does it prevent them from being enjoined.

Certainly licenses to be issued and we would submit shipments to be made, are not something that is

ongoing. They are a new thing. If we are going to ship something tomorrow, that is something new. Same thing like if we were going to issue a license. To say because it's been done before I should not be enjoined, flies in the face of a rather long line of NEPA cases where almost everything has been done before. Roads have been built before, dams have been built before.

THE COURT: That is not quite what I mean. Maybe I haven't made it clear. When an injunction is sought to prevent the construction of a dam, if the injunction isn't granted and the dam is built, the action is irreversible. You are not going to restore the situation by letting the water out of the reservoir and then tearing down the dam. The damage has been done. It can never be repaired.

In this situation, the damage is not at all so clear, even though as you say, a new license is required for each shipment. There is an ongoing program in the sense that people are relying on the continuation of the shipments. Power plants rely on the ability to replenish their nuclear materials. People that produce Pacemakers are relying on the continued availability of special nuclear materials. People who have research projects in progress rely on the continued availability

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of trace material. And I can't see that this is perfectly comparable to the situation where you are enjoining a construction project which has irreversible effects.

MR. ZEDROSSER: Your Honor, certainly in one respect it's not, because here we are not saying the dam shouldn't be built. We are not saying that these people with Pacemakers and whatnot should not receive their plutonium or other special nuclear material. All we are saying is that it shouldn't go by air and all the federal government can say is well, it's a matter of convenience, speediness and cost effectiveness.

This is not to say that these various people wouldn't get their materials. What we are talking about is will it go by ship or by plane or by land surface transportation or plane. When you put the irreversibility question in the context of this case, if there is a flight tomorrow and we have an accident, is that reversible? Obviously not. And the result would be far worse than the worst damage I could think of or the worst possibility I could think of.

THE COURT: The result might be. It might not necessarily be. There are a number of possibilities. Let's assume, for example, that one flight in ten thousand

crashes. I don't think that is true, but just for the purpose of discussion, let's assume that is true. Let's assume that one flight in a thousand carries special nuclear materials. That means that the chances that a crash is going to occur is one in ten million. That is, crash of a plane carrying special nuclear materials is one in ten million. And the regulations now in force require that the material be packaged in such a way as to effectively minimize the possibility of release of the material in the event of a crash. So I think there is probably a fifty percent chance or maybe better that a crash won't result in the release of any materials. So now we are up to forty million. Even if it does, it isn't at all clear that people would be injured as a result of it.

In other words, I can imagine a situation in which material could be released and no one could be injured because of either absorption or dissipation.

MR. ZEDROSSER: The probability question is an intriguing one and Mr. Pinkel in one of the affidavits that we submitted made the observation that even if you say something has only a one in a million probability, it can happen the first time out as well as on the millionth time out, or anywhere in between. One wonders

what the probability of the accident was out at JFK last week. Yet it happened, and yet its results are there.

THE COURT: You are not asking me to enjoin all flights because there are air crashes. An air crash could happen over Times Square and kill ten thousand people or over Shea Stadium and kill even more. Yet we don't enjoin the flights that take off every minute from LaGuardia and pass right over Shea Stadium. We have got to consider probabilities and we have got to weigh the inconvenience of the injunction against the possibility that the injunction is going to prevent a worse harm than the injunction itself will cause.

MR. ZEDROSSER: I quite agree with the Court's use of the word inconvenience because I think that at best is what the U.S. government has demonstrated here. One wonders how much inconvenience is worth when measured against even a possibility of a large loss of human life.

THE COURT: Let me ask you this: Are there affidavits here which establish that the likelihood of release of nuclear materials is greater when they are transported by air than when they are transported by alternative means of transportation?

MR. ZEDROSSER: Yes, your Honor, certainly.

THE COURT: Let me ask the government's attorney,

then, what is there in the papers you have submitted which indicates a lack of feasibility of transporting by surface means?

MR. RICHTER: We are not saying that there is a lack of feasibility. We are saying that by being forced to use surface means, that one, it's unnecessary that that happen and, two, not only would it be inconvenient, but there could be definite harmful effects. For example, air transportation of special nuclear materials most usually occurs in the United States import export program, especially nuclear materials. It is extremely important that the United States continue to be a major supplier of special nuclear materials abroad. It is important for several reasons. First, as far as balance of payments goes, it's very important that this occur. Secondly, it is important from the standpoint of controlling the spread of nuclear weapons through the world.

By being a major supplier of special nuclear materials, the United States is required by the Atomic Energy Act of 1954 to put safeguards on the use of the materials, so that they can't be used for nonpeaceful purposes. At the present time it is a very crucial situation. There have been delays in providing enriched

uranium to foreign countries because of the ~~opposition~~ abolition of the AEC and the creation of the Nuclear Regulatory Commission. What is happening is that the pipelire of enriched uranium in particular is being dried up and that within a short period of time some plants will have to close down abroad.

The government hopes to speed up the licensing by the NRC of shipments of enriched uranium abroad. If those shipments cannot go by air, then it will mean the shutdown of plants abroad; it will mean that foreign countries will view the United States as an unreliable source of special nuclear materials and what it might mean is that foreign countries themselves will begin to enrich uranium, will begin to fabricate plutonium by themselves or might turn to other sources which do not put controls on the use of special nuclear materials as the United States does, and it could mean a worldwide use of these materials without controls on it to make sure that they are only used for peaceful purposes.

So there can be a very dramatic effect if an injunction is issued at this time on the transportation of special nuclear materials, quite above mere added inconvenience.

MR. ZEDROSSER: One wonders if it is going to

take five days by ship or eight hours by plane, why all of these disastrous foreign policy things are going to happen. We are not trying to enjoin all transportation. Mr. Richter keeps, in the way he makes his arguments, is phrasing it as if we were. We are not. We are talking about a difference in time and a different kind of transport. That is nothing that he said that directed itself to what your Honor I think is asking, which is why can't it go some other way.

THE COURT: Where do these shipments go? What parts of the world? Europe? South America?

MR. RICHTER: They go primarily to Europe and Japan in the east. The United States has international agreements for cooperation with approximately twenty-eight or twenty-nine countries, including most of the countries of western or industrial Europe and also with two international associations, and additional countries receive materials through those associations.

THE COURT: With respect to Japan, we are not talking about five days for transportation by ship.

MR. ZEDROSSER: No, nor do I think empires would crumble because of the difference in time, quite frankly. Nothing has been demonstrated to indicate that it would.

MR. RICHTER: Nothing has been demonstrated at

all by the state first as to what would be the impact on foreign policy and foreign relations of the United States if there was such a ban, despite the fact that there is an extensive affidavit from Dr. Dixie Lee Ray, who used to be Under-Secretary of State for the State Department on this point.

Secondly, the state is arguing without any basis in their affidavits as, for example, the harm in shipping enriched uranium by air. Their own experts admit in their affidavits that there is no reason not to ship enriched uranium by air. And again the key point in all of this, as you said, your Honor, it's for this Court to decide whether there is a high probability of harm. There is no high probability of harm, there is no showing of irreparable injury by the plaintiff and until there is a showing of irreparable injury by the plaintiff, one doesn't even have to get into the question that the state is now posing.

THE COURT: I suppose that there is still another alternative. The proposed injunction would only prevent air shipments in the air space over New York State, is that correct, Mr. Zedrosser?

MR. ZEDROSSER: No. We have asked for one dealing with the United States as a whole.

THE COURT: I was going to say, if it were only limited to New York State, then it wouldn't affect the shipment to Japan because I'm sure they don't go out of New York airports, and would there be a viable alternative in shipments going from Philadelphia or Chicago to -- or Boston to Europe?

MR. RICHTER: If I may say, the difficulty that would be confronted there is that if you say you can't go from New York State, then the other areas are going to say, well, why should it go from their area, if suddenly the people in New York State are saying you can't go from there.

THE COURT: Are you worrying about the domino effect my decision might have?

MR. RICHTER: Yes, your Honor.

MR. ZEDROSSER: It's certainly true that while we are asking for relief generally, this being for the attorney general's office of the state of New York, we do have a special interest in protecting the people of the state of New York, and I would say we do have a particular interest in those flights. I would have to be candid, however, in saying that if there were a crash across the river, I'm not so sure those particles will respect state lines, but still we certainly do have a particular

interest in flights in and out of places like JFK Airport, for example.

That presents a special problem because of where it is located, in a city of eight million people. As far as not debating foreign policy with Mr. Richter, I am quite surprised by his expression of surprise. I almost always thought the U.S. government raises foreign policy when they want to eliminate debate because they take the position that foreign policy is whatever they want it to be. If one wanted to raise that, I think every newspaper that I have read in the last two weeks has questioned whether or not it is a good way of safeguarding the proliferation of nuclear materials by supplying them. Some people have said that it is a rather ironic method of safeguarding proliferation.

THE COURT: But the point I think you intentionally miss, when we supply them, we supply them with safeguards. When West Germany supplies Brazil, it supplies them with fewer safeguards against the use of those materials either fresh or spent to produce bombs.

MR. ZEDROSSER: There are problems that are common no matter who supplies them. This is particularly apropos Mr. Richter's remarks about enriched uranium. While certain kinds of enriched uranium may not have a

health effect, they certainly raise a terrorism problem because they certainly are usable as weapons. No matter who supplies them, in the way they are supplied now they are particularly vulnerable to a terrorist diversion. I think going back to something the Court raised, the cases seem to make it clear that the possibility of irreparable harm is all that is required, and it seems to me that the standard of a very high probability if I have it correctly, is frankly not found in the cases. And I cite, you know, Second Circuit and Southern District cases.

THE COURT: I don't think I used the expression very high probability. I think I used the expression substantial probability. If I didn't, I amend my statement nunc pro tunc.

MR. ZEDROSSER: Judge Ward in the Chelsea Post Office case very recently affirmed by the Second Circuit used the term possible harm.

THE COURT: Again, that is one of the cases where you are going to prevent an anticipated construction that is going to alter in an obvious way the pattern of living in the immediate neighborhood. We don't have that situation here. We are not trying to prevent a change in the status quo. You are trying to create a change in the

status quo with your injunction and that is why I am going to have to look at it a little differently than the courts looked at it in the cases that you cite.

MR. ZEDROSSER: I would urge that the Court do look at it differently in this case, that where the risk, if it does come to pass, is so grave where it involves large loss of human life, less likelihood need be shown than when we are talking about changing a neighborhood or fish in the river, or something of that sort.

THE COURT: I agree. Where we are talking about continuation of life as opposed to the preservation of aesthetic values, obviously the degree of probability required for the grant of the relief is substantially reduced.

MR. ZEDROSSER: We have indicated in our affidavits that there is a greater danger in this mode than in the other modes of transport and we still haven't gotten anything back from the government other than convenience, speed, and cost effectiveness, to really counterbalance that side. You know, when they say their major problem is foreign policy, that is another way of saying that the stuff isn't used in this country all that much, at least not for reactive purposes. As we point out in our brief, there is a very good reason for that,

that the NRC has put off the use for commercial purposes of plutonium as a reactive fuel pending the study of the safeguards. So in a funny kind of way, by focusing on foreign policy and saying that is their biggest problem --

THE COURT: That is true of plutonium. It isn't true of uranium 233 and 235. Those are being used right now in commercial power plants.

MR. RICHTER: Except for 233, your Honor, which is experimental.

THE COURT: I'm sorry. I should have said 235.

MR. ZEDROSSER: There we don't have trips to Japan to worry about.

THE COURT: I assume by the same token we are not flying much plutonium to Japan, that is in commercial quantities. We may be flying it there for experimental purposes, I don't know.

What do you gentlemen envision, that I will take these ~~pages~~ papers, take the matter under advisement, decide it on the ~~pages~~ papers if I can, and schedule an evidentiary hearing only if it appears necessary?

MR. RICHTER: The government would like that, your Honor.

MR. ZEDROSSER: Yes, we would, as indicated in our brief, we think we have shown enough in our papers

and we would hope the Court would take it under advisement.

THE COURT: All right. I will to that. Is there anything else that you'd like to add?

MR. RICHTER: Yes, there are two points I would like to add, your Honor. First, I would like to point out that Congress has passed what is called the ---the House of Representatives has passed what is called the Scheuer amendment. Congressman Scheuer of New York introduced an amendment to the Nuclear Regulatory Commission Authorization bill, and I have a copy which I will now hand you. Discussion of this amendment and the terms of the amendment as it appeared in the Congressional Record. I believe the state is already familiar with this.

THE COURT: All right.

MR. RICHTER: My understanding is that the matter should be resolved, that is, whether Congress as a whole will pass this amendment or not, should be resolved by the 10th or 11th of July or perhaps slightly thereafter. It is the feeling of the government that this should be dispositive of the case. If the amendment is passed and signed by the President, then it will moot the question at least insofar as NRC is concerned as to whether plutonium can be shipped by air. If the amendment is not passed,

then I think it is quite clear that Congress is saying that because the NRC is studying the matter, they will defer for that study and they will permit plutonium to be transported by air at the present time.

THE COURT: You didn't say so, but I infer from what you do say that the amendment would prevent the shipment of plutonium by air.

MR. RICHTER: That is correct. The amendment as phrased right at the top of the page provides that plutonium may not be shipped by air until the Nuclear Regulatory Commission certifies to the Joint Commission on Atomic Energy of the Congress that a safe container has been developed and tested which will not rupture on crash and blast testing equivalent to the crash and explosion of a high-flying aircraft.

THE COURT: Isn't that a very clear indication that at least the House of Representatives believes that New York State has a good case, at least insofar as plutonium is concerned?

MR. RICHTER: It should be noted, your Honor, that on the voting on the amendment there are 165 votss in favor of the amendment, and when you total up the number that did not vote and the number that voted against it, which are listed on page 589 of the Congressional

Record, the vast majority of the House of Representatives either did not vote or voted against the amendment. And I would also like to note, your Honor, that there were no hearings on this amendment.

What I have handed to you as far as I know is the entire legislative history of the amendment. I think in light of that, one has to say that the House of Representatives has passed this amendment, but I don't think this should be taken as a reason for now enjoining or preliminarily enjoining licensing.

THE COURT: No, but I think it is one factor which certainly weighs on the side of the balance which favors New York State's contentions.

MR. RICHTER: That's correct, your Honor. But similarly, if the Congress as a whole does not enact this amendment, then I think it shows that Congress is saying that plutonium should be continued to be allowed to be carried by air. All we are saying is that the Court should defer any decision it makes until Congress has spoken and this bill could easily moot this case.

THE COURT: Okay.

MR. ZEDROSSER: Your Honor, I have a number of responses to that. I think they are terribly important because I think he's rather misconstrued what is going on

here. What he was reading from I guess was the comment of Mr. Scheuer rather than from the amendment itself. The amendment says that NRC shall not license any shipments by air transport of plutonium, and then has an exception for certain kinds of medical devices. Number one, it deals not at all with ERDA ~~as~~ and as the defendants' affidavits indicate, ERDA ships around a lot of these materials, perhaps more than NRC licenses. That is number one.

Number two, as far as the question of the meaning of this and the question of whether there was a hearing, there was a study by the Joint Committee or by the Joint Committee on Atomic Energy. We appended a copy of that study ~~record~~ report to Mr. Shea's affidavit. That study made by people, among others by Dr. ~~Calz Corman~~ Karl Z. Morgan, said that the danger of an aircraft accident and resulting risk of contamination from plutonium, other actinides, and other category 1 material is sufficiently grave as to warrant the total restriction to ground and water transportation of such shipments. So to say that this was done in haste by implication by congressmen who didn't know what they were doing, is nonsense. This was a study by a joint commission panel and it came out with that recommendation.

MR. RICHTER: May I ask Mr. Zedrosser the date of that?

MR. ZEDROSSER: Yes. I think it's --

MR. SHEA: September 1974.

MR. ZEDROSSER: Any implications that might be drawn if it does not pass, it is clear from conversations we have had with Congressman Scheuer who quite accurately is stated to be the principal spokesman for the measure, indicated that there was no intent by the Congress and certainly none in the record if the government is willing to look at it, to have any impact on the applicability of NEPA, whether or not Congress decides to prohibit it of its own motion affects not one whit the applicability of a law Congress passed before. I strongly urge that the consideration and determination of this preliminary injunction motion not be deferred because I don't think that this congressional action, one, would solve all the problems even if it were passed in its present form; it clearly would not, and number two, if it isn't passed, would militate in any way against our getting an injunction.

THE COURT: All right. Any other point?

MR. RICHTER: Yes, your Honor. I did want to note that the plaintiff's claim that they have accurately

stated and agreed upon, or nondisputed set of facts in point 3 of their brief, is not correct. The point that they make, which is of most importance to note, is that they say based upon our affidavits, particularly the affidavit of Mr. Donald Nussbaumer, that a container carrying special nuclear materials would not survive approximately twenty percent of air crashes when you look at it purely from the point of view of impact, that is, in approximately twenty percent of air crashes, the impact would be such that the container would fail, that is not an accurate statement of Mr. Nussbaumer's affidavit, because he goes on to note that the study he was relying upon, which was a study prepared by the Sandia Corporation, which is a nonprofit subsidiary of Western Electric, just looked at the standards for containers as stated in NRC regulations. In point of fact, an additional study was made which is Exhibit D to Mr. Nussbaumer's affidavit showing that the containers used to transport special nuclear materials far exceed the requirements of NRC regulations, and while the extent it exceeds it has not been quantified, although studies are now going on in an attempt to do so, the point is that the plaintiffs have incorrectly stated the conclusion of Mr. Nussbaumer and in point of fact these containers can survive the vast

majority of plane accidents.

Finally, as to the question of what ERDA would do if the amendment were passed, ERDA has not taken an official position on that yet because the amendment has not passed. At such time it will. In all likelihood ERDA will continue its present policy which is in shipment not related to defense purposes, it will follow the regulations of NRC and other governmental agencies and, therefore, if this bill were passed in all probability in nondefense shipments ERDA will not use air transportation when it is transporting plutonium.

MR. ZEDROSSER: May I ask what effect it would have on defense transportation?

MR. RICHTER: I am not in a position to state the formal ERDA policy because obviously it is senseless for ERDA to take a position until the amendment has been passed if it is going to be passed.

MR. ZEDROSSER: On the question of undisputed facts, I call the Court's attention to page 21 of our brief where we discuss this question of the Sandia lab report. It is kind of interesting that the federal government charters these tests and you know, when they come out right they say, our test shows, and if they don't come out right, they say this was a subsidiary of

some private company that did it. But be that as it may, it is interesting that at levels of impact which the USEPA considers to be more indicative of actual crash environment than the so-called regulatory levels, the containers fail. It seems to me that basically what the federal government is saying here is, in each case, well, you know, it's not quite so bad as you say it is. But when you get right down to it, even on their own statements enough of ~~the statistics~~ it sticks, and they can't get around the fact that even on their own reports that they commissioned themselves, that there is a possibility of these things breaking. Not an irrational possibility, one that these testers that they hired can advert to and quantify.

We think that on balance our statement is a correct one and we leave it to the Court to refer to the citations we have made to verify that.

Finally, a minor point. If we were to look at congressional votes in all cases the way Mr. Richter would have us do, one wonders how the Congress would ever proceed with anything. Suffice it to say for whatever it is worth that that measure passed in the normal course the way our country passes legislation, or at least through one house.

THE COURT: I will have to treat it as having

been passed, even if it passed by a small margin and even though a lot of the representatives were not present or didn't vote. I will take the matter under advisement and if it appears that an evidentiary hearing is necessary, I will let you know and we will set a mutually satisfactory date.

STATE OF NEW YORK

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IN CHARGE OF
ENVIRONMENTAL PROTECTION
BUREAU

July 17, 1975

Honorable William C. Conner
United States District Judge
United States Court House
Foley Square
New York, New York 10007

Re: The State of New York v.
The Nuclear Regulatory
Commission, et al.
Docket No. 75 Civ 2121 (WCC)

Dear Judge Conner:

Our office was only recently advised that last Wednesday, July 9, 1975, a shipment of 45.062 kilograms of highly enriched uranium 235 (93.15% enrichment) had been transported by truck through New York City to John F. Kennedy Airport. At the airport the shipment was placed aboard a Seaboard World Airways aircraft which left the United States with an ultimate destination of Frankfort, Germany (via Shannon, Ireland, and London, U.K.).

To our knowledge the United States Attorney's Office did not apprise the Court or the Attorney General of the State of New York of the imminence of this extremely large shipment, which was licensed by the NRC, and obviously within the class of shipments at issue in the pending litigation brought by the State. Being of such a high level of enrichment, uranium in this form constitutes a very attractive target for a terrorist group since the material can be converted into a nuclear explosive (See paragraph 42 of Mason/Leamer affidavit and Exhibit "C" annexed thereto, pp. 7-8).

The Court in part based its denial of plaintiff's motion for a temporary restraining order on the fact that it was not satisfied that there was a threatened air shipment of special nuclear materials (Transcript May. 7, 1975 p. 23). At that time the United States Attorney's Office clearly assured the Court that it would make an investigation regarding contemplated

flights of significant quantities of special nuclear materials into or out of any New York airports at any time up to the point of a hearing and would inform our office if there were to be any such flights (Transcript pp. 30-31).

This recent shipment emphasizes the immediacy of the need for the preliminary injunction requested by the State of New York.

This is to notify you as well that the defendants are in default for their failure to answer the Complaint in this action within the time specified by the Federal Rules of Civil Procedure. This notification is made without prejudice to our right to move for a default judgment under Rule 55 of the Federal Rules of Civil Procedure.

Very truly yours,

LOUIS J. LEFKOWITZ
Attorney General
By

JFS:nv

JOHN F. SHEA, III
Assistant Attorney General

cc: Charles Franklin Richter, Esq.

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK, Plaintiffs,	:	
-against-	:	AFFIDAVIT
THE NUCLEAR REGULATORY COMMISSION, et al., Defendants.	:	75 Civ. 2121 (MCC)

STATE OF CALIFORNIA)
: SS.:
COUNTY OF SAN FRANCISCO)

JOHN W. GOFMAN, being duly sworn deposes and says:

1. I previously submitted an affidavit in support of plaintiff's motion for a preliminary injunction sworn to on June 10, 1975. I now submit this affidavit to correct a certain arithmetical error carried over into the text of that affidavit from Exhibit B which was annexed thereto.

2. I submit herewith a corrected version of the report annexed as Exhibit B to my previous affidavit.

3. There is an error of arithmetic on page 23 of the report annexed as Exhibit B to my previous affidavit. The error in no way affects any of all the calculations for cigarette smokers, which, of course, is the main thrust of the report. It does reduce the risk for the non-smokers by the factor of 10. The figure 0.08 on page 23 should be 0.008 (I had failed to carry my 10-fold factor for non-smokers from Table 6 into the calculations for Tables 9 and 10).

790

As a result,

All values in Table 9 are to be divided by 10.

All values in Table 10 are to be multiplied by 10.

In ensuing text plus in the Summary, any values taken from Table 9 or 10 require correction, as do the results based upon them.

4. The affidavit uses some values from Tables 9 or 10, and hence certain conclusions must be alterd in terms of total deaths; other conclusions are not changed, since the affected population would still receive multiple lung cancer doses.

Paragraph 8 Should show 1.4 micrograms, not 0.14 for non-smokers.

Paragraph 10 350 times for non-smokers should read 35 times for non-smokers.

Paragraph 12 Change 0.14 micrograms to 1.4 micrograms.

Paragraph 21 Since the lung cancer dose is 1.4 micrograms, not 0.14 micrograms, the calculations should be,

$\frac{5.1}{1.4} = 3.64$ lung cancer doses instead of $\frac{5.1}{0.14} = 36.4$ doses for non-smokers under Dr. Resnikoff's Case A. For non-smokers, under Case C from Dr. Resnikoff's April 25, 1975 affidavit,

lung cancer doses $= \frac{19.5 \times 10^4}{1.4} = 0.139 \times 10^6$ lung cancer doses

instead of $\frac{19.5 \times 10^4}{0.14} = 1.39 \times 10^6$ and, for the 6.2 million non-smokers, it should read approximately one in fifty will die instead of 1 in five. Therefore, it should also read, 120,000 instead of 1.2 million. Total death predicted becomes 6.3 million persons instead of 7.4 million.

John W. Gofman
JOHN W. GOFMAN

Sworn to before me this
21 day of July 1975

Louie Bertolucci
NOTARY PUBLIC

OFFICIAL SEAL
LOUIE BERTOLUCCI
NOTARY PUBLIC - CALIFORNIA
SAN FRANCISCO COUNTY
My comm. expires APR 27, 1979

401 Judah St., San Francisco, CA

CORRECTED COPY
OF
EXHIBIT B.

THE CANCER HAZARD FROM INHALED PLUTONIUM

John W. Gofman

May 14, 1975

CNR Report 1975-1R

COMMITTEE FOR NUCLEAR RESPONSIBILITY
P.O. Box 2329
Dublin, California 94566

792

Foreword

The calculations presented here, and in the other reports of this CNR series, represent a first approximation of the biological hazards from plutonium exposure.

In essence, these are studies of the dosimetry of plutonium exposure. There are certain critical voids in mankind's knowledge of the physical and physiological parameters which determine the dosimetry, and thus we have made necessary assumptions which are all clearly identified.

It is anticipated that as additional data become available, the calculations herein will be updated to take them into account.

Summary of Conclusions

(1) The lung cancer potential in humans from inhaled insoluble compounds of plutonium (such as PuO_2 particles) has been grossly underestimated by such authoritative bodies as the International Commission on Radiological Protection and the British Medical Research Council.

(2) The term "lung cancer dose", used freely in this report, has a specific scientific definition, namely, the reciprocal of the lifetime lung cancer risk per unit of radiation, whatever be the units under discussion. In more popular terms, one "lung cancer dose" of a carcinogen such as plutonium introduced into a population will assure one extra lung cancer death.

(3) The lung cancer hazard of plutonium inhalation is much higher for cigarette-smoking humans than for non-smokers. The calculations presented here suggest the following values for inhalation of insoluble plutonium particulates.

For Cigarette-Smokers:

Pu^{239}

(a) 0.058 micrograms deposited Pu^{239} represents one "lung cancer dose".

(b) 7,830,000,000 "lung cancer doses" per pound of Pu^{239}.

Reactor-Pu

(a) 0.011 micrograms deposited reactor-Pu represents one "lung cancer dose"

(b) 42,300,000,000 "lung cancer doses" per pound of reactor-Pu.

For Non-Smokers:

Pu^{239}

(a) 7.3 micrograms deposited Pu^{239} represents one "lung cancer dose".

(b) 62,600,000 "lung cancer doses" per pound Pu^{239}.

Reactor-Pu

(a) 1.4 micrograms deposited reactor-Pu represents one "lung cancer dose".

(b) 338,000,000 "lung cancer doses" per pound of reactor-Pu.

(4) While the estimated hazard is about 127 times lower for non-smokers than for smokers, the hazard for non-smokers for reactor-Pu, which is what nuclear energy provides, is indeed severe. Clearly, there would be no source of comfort available even if no one in the population smoked cigarettes.

(5) The reason for the gross underestimate by ICRP or BMRC is their use of a totally unrealistic, "idealized" model for the clearance of deposited plutonium from the lungs and bronchi, plus their non-recognition of the bronchi as the true site for most human lung cancers. The erroneous model used by such organizations fails totally to take into account the effect of cigarette-smoking upon the physiological function of human lungs.

(6) Plutonium nuclides, or other alpha particle-emitting nuclides, in an insoluble form, represent an inhalation hazard in a class some five orders of magnitude more potent, weight for weight, than the potent chemical carcinogens.

(7) The beagle dog data on lung cancer production from inhaled plutonium already are in good general accord with the human estimates of this report, even though it is widely realized that the current beagle data must be overestimating the lung cancer dose. When the beagle data became available at lower dosages, it is virtually certain that they will not be significantly different from the human estimates.

(8) None of the calculations presented in this report make any use of "hot particle" theories and are in no way dependent upon such theories. Unfortunately, so much effort has been expended, for example, by the British Medical Research Council, in countering "hot particle" theories that they overlooked the real cancer hazard derivable from straightforward dosimetry, as presented here. It turns out that dosimetry provides cancer risk estimates well within order of magnitude agreement with those predicted by Geesaman-Tamplin-Cochran.

(9) The lung cancer potential of insoluble particles of plutonium compounds should result in worldwide rejection of nuclear fission energy involving any kind of plutonium handling or recycling. No meaningful mitigation of this problem would be achieved even if cigarette smoking stopped totally.

THE CANCER HAZARD FROM INHALED PLUTONIUM

John W. Gofman*

Introduction

At this critical juncture for societal choices of energy supply for the future, one possible choice is a nuclear fission economy based upon the element plutonium (element 94). Tamplin and Cochran [1] have pointed out that the U.S. AEC projected that over 4 million megawatts of nuclear capacity will be installed between 1970 and 2020. Based upon this estimate, Tamplin and Cochran pointed out that over the lifetime of these plants this installed capacity could result in a cumulative flow of approximately 200 million kilograms (440 million pounds) of plutonium through the nuclear fuel cycle. Putting this much plutonium "through the nuclear fuel cycle" means plutonium becomes a commonplace article of commerce, being handled by thousands of workers and being transported on highways, railways, and airways in numerous shipments per day.

Plutonium is widely recognized as a potent carcinogen, and is of particular concern in the form of insoluble particles of plutonium dioxide (PuO_2) as a very potent agent for the production of lung cancer in man. Estimates have been made by several individuals and groups of the number of human lung cancers to be expected for the inhalation of specified quantities of PuO_2 particles. Such estimates range over several orders of magnitude, with Cohen [2] providing the lowest estimate, Tamplin-Cochran [1] providing the highest estimate, and the British Medical Research Council [3] providing evidence suggesting an intermediate value. Unfortunately, the problem has been clouded by needless polemic discussion of whether or not the "hot particle" hypothesis (Geesaman) [4]

*John W. Gofman, M.D., Ph.D. is Professor Emeritus of Medical Physics, Division of Medical Physics, University of California, Berkeley, California.

is correct. The issue of PuO_2 particle carcinogenicity can be approached in a straightforward manner with no reference whatever to "hot particle" theories.

It is our purpose here to present such a straightforward analysis leading to some reasonable limits for the expected numbers of human lung cancers for the inhalation of plutonium particulates. There are certain crucial voids in our knowledge of the behavior and disposition of PuO_2, once deposited in the lung. As a result, the estimate of the number of cancers becomes dependent upon the assumptions used where evidence is lacking. Cohen, in his analysis, simply overlooked the important problems of behavior of the PuO_2 in the lung. The British Medical Research Council paid lip service to certain of the problems, but then neglected to indicate how failure to address the problems might provide a falsely low estimate of lung cancer hazard from plutonium inhalation.

Detailed Analysis of Lung Cancer Induction by Plutonium

The analysis of the lung cancer-producing properties of inhaled plutonium particulates (usually, but by no means necessarily, insoluble particles of PuO_2) proceeds by several steps.

Step 1: Analysis based upon the known carcinogenicity of x-rays, gamma rays, and neutrons for human lung tissue, followed by analysis of the dose to be delivered to lung tissue by inhaled particulates of plutonium, assuming the plutonium delivers its radiation to the entire mass of broncho-pulmonary tissue. Since the nuclear power industry will provide mixtures of plutonium nuclides, rather than the predominant nuclide, Pu^{239}, the analysis will consider effects of Pu^{239} and effects of Pu mixtures from nuclear power reactors, to be designated simply as "reactor-Pu".

Step 2: Analysis of the nature of the problem of non-uniform distribution of plutonium within the lung and the crucial problem of which cells in the broncho-pulmonary system are involved in human lung cancer production.

798

Step 3: Final estimates of the probable limits to be placed upon the lung cancer expectations per pound of plutonium deposited in lung tissue of human populations.

Step 1. Analysis based upon the known carcinogenicity of x-rays, gamma rays and neutrons for human lung tissue.

There has been, for several years, conclusive evidence that human population groups exposed to x-rays, or to combinations of x-rays, gamma rays, and neutrons have developed an excess of lung cancers that must be attributed to radiation exposure. Gofman and Tamplin[5-23] have presented comprehensive analysis of the quantitative aspects of such lung cancer production. More recently the BEIR Committee presented its analysis of the same evidence.[24] We shall discuss the differences (minor, at best) in the conclusions to be derived from both analyses. There is abundant additional proof that broncho-pulmonary irradiation produces lung cancer in man from the tragic experience of uranium (and other) miners exposed to radon gas and daughter products of radon. However, we shall refrain from using these latter data for quantitative purposes because virtually everyone realizes that dose estimation in rads or rems is exceedingly tenuous at best for the miners.

The analysis of Gofman-Tamplin led to the conclusion that, for diffuse lung irradiation, 1 rem means 2% increase over the spontaneous lung cancer death rate each year in an exposed population, once the latent period of some 10-15 years is passed.[25] Precisely how long this 2% per year increase (in lung cancer death rate) persists is not known from direct evidence. A modestly conservative estimate (agreed to by many observers) is a persistence of 30 years, but persistence for the remainder of the life span of the exposed population cannot be ruled out. The BEIR Committee recognized this uncertainty in its report. The value of 2% increase over spontaneous lung cancer death rate, according to Gofman-Tamplin, applies for young adults of the 20-30 year age range.

799

Some workers have analyzed lung (and other cancer) production by radiation in terms of the absolute number of cancers produced per rem exposure of a population, with no reference to a percent increase over the spontaneous occurrence rate. Cohen has chosen this approach, with the strange statement that:

> "It may be noted that our calculations employed the "absolute risk" model of Reference 5 (the BEIR report) rather than the "relative risk" model. Primarily this is because the age-dependent risk of each type of cancer is not readily available, and the calculations are more complex. In ref. 5, the relative risk model gives a two times larger effect. However, the available evidence tends to support the absolute risk model and it seems to be preferred by most experts in the field, so its use is justified by our aim to determine the most probable effects."

The available evidence, in the opinion of the present author, is very much in favor of the opposite conclusion - namely, that the relative risk method has very sound foundation indeed. A variety of pertinent sources of evidence points strongly to radiation action as a multiplier of other carcinogenic influences (e.g., radiation multiplies the effect of cigarette smoking in the uranium miners). If radiation acts as a multiplier, then the best approach is the relative risk method, with a specified percent increase over the spontaneous cancer fatality rate per rem of exposure. The BEIR Committee was unable to choose between the two approaches, commenting as follows: (p.99, BEIR Report)

> "Absolute risk estimates are generally more useful for purposes of radiation protection than are relative risk estimates, because they specify directly the number of persons affected. On the other hand, if the risk due to radiation were found to increase in proportion to the natural risk, then the relative risk would provide the more appropriate estimate. Since the existing knowledge of radiation carcinogenesis is not always sufficient to indicate which type of estimate applies best in a given situation, both the absolute risk (where possible) and the relative risk are given in this report."

Since the present author considers the scientific evidence overwhelmingly in favor of the relative risk method, that method (including BEIR's relative risk estimates)

will be used in all calculations here. It is a very simple matter, as will be noted, to convert the relative risk estimates, scientifically sound, into absolute numbers of lung cancer fatalities. Moreover, in periods of rapidly changing lung cancer death rates (such as the 1940-1975 period in the USA), the relative risk method can avoid serious errors of under-estimation. The absolute risk method, using data for populations exposed in or before 1945, may be truly irrelevant in making estimates for the real world of 1975.

The most recent datum from the American Cancer Society provides the estimated value, 63,500 lung cancer deaths per year (1975) for men in the USA.[26] Virtually all these lung cancer deaths are in men over 25 years of age, so they may be taken to occur in a population of approximately 50 million men (those over 25 years of age).

The spontaneous (or as BEIR calls it, the "natural") lung cancer death rate, therefore, is

$\frac{63500}{5\times10^7}$, or 1.27×10^{-3}/year. Expressed otherwise, this means 1.27 fatal lung cancers per 1000 persons per year, spontaneously occurring in men over 25 years of age.

If we now utilize the Gofman-Tamplin figure above of a 2% increase over the spontaneous rate per rem of exposure, we arrive, per rem, at the following:

$(0.02)\ (1.27\times10^{-3})$, or 2.54×10^{-5}/year as the expected increase in lung cancer fatalities per year per rem of exposure. Henceforth in this discussion, we shall refer to estimates arrived at in this manner as "Gofman-Tamplin" estimates.

The BEIR Committee arrived at a somewhat lower percentage increase per rem of exposure. However, BEIR realized that the exposed subjects had not been followed long enough to be sure they were on the "plateau" of observed effects. We may quote BEIR Report (p. 156) as follows:

> "It is possible, therefore, that in the final analysis the absolute risk in these groups will approach $2/10^6$/year/rem and the relative risk will reach 0.5% or higher. For the three groups (miners and Japanese

survivors) in which up-to-date information is available, it is significant that many new cases have been added during the past few years."

This is a powerful admission by the BEIR Committee. They are admitting that their estimate is only four-fold lower than Gofman-Tamplin and admitting that when all the evidence is in, they may be even closer to Gofman-Tamplin estimates.

Let us not anticipate the future, and simply proceed utilizing the BEIR figure of 0.5% increase in relative risk per year per rem, realizing that it is not a most conservative public health estimate. *

Since 0.5% is 1/4 of 2%, we would say that BEIR should conclude that the risk of fatal lung cancer, for USA subjects in 1975, is

$1/4 \times 2.54 \times 10^{-5}$/year/rem, or 6.3×10^{-6}/year/rem.

Henceforth in this discussion, we shall refer to estimates based upon this number as "BEIR" estimates.

Cohen, in his analysis, quotes BEIR as giving "The cancer risk of radiation to the lung as 1.3×10^{-6}/year-rem for adults". This low figure, based upon absolute data from 1945, may be truly irrelevant for exposure of populations today.

Henceforth in this discussion, we shall refer to Cohen's analysis based upon the 1.3×10^{-6} lung cancer deaths/year-rem as the "Cohen" estimate.

It was stated above that most observers (including BEIR Committee) consider the "plateau" effect may persist for 30 years, or even longer. And while not truly conservative (in the absence of positive knowledge), we shall, for present purposes, utilize the potential underestimate of 30 years on the "plateau".

This leads to the following total lung cancer production per rem as follows:

"Gofman-Tamplin" $30 \times 2.54 \times 10^{-5} = 7.62 \times 10^{-4}$ lung cancer deaths per lifetime-man-rem.

"BEIR" $30 \times 6.3 \times 10^{-6} = 1.89 \times 10^{-4}$ lung cancer deaths per lifetime-man-rem.

"Cohen" $30 \times 1.3 \times 10^{-6} = 3.9 \times 10^{-5}$ lung cancer deaths per lifetime-man-rem.

*See Note 1 in "Supplemental Notes".

802

The Concept of the "Lung Cancer Dose"

It has become commonplace recently to alter such presentations of risk into another format, namely, that which describes "the lung cancer dose". This is a simple and useful way to present the estimates. If the lifetime risk is x per man-rem, then the "lung cancer dose" is (1/x) man-rems.

Thus, for illustration, if the lifetime risk is 1 out of 10, which means 0.1 per man-rem, then the "lung cancer dose" is 1/0.1, or 10 man-rem.

Applying this relationship to the estimates above, we derive the following:

	"Lung Cancer Dose", in man-rem
"Gofman-Tamplin"	$\frac{1}{7.62 \times 10^{-4}}$, or 1310 man-rem.
"BEIR"	$\frac{1}{1.89 \times 10^{-4}}$, or 5290 man-rem.
"Cohen"	$\frac{1}{3.9 \times 10^{-5}}$, or 25,600 man-rem.

Calculation (Step 1 level) of "Lung Cancer Dose" for Insoluble Inhaled Plutonium Particles

The Cohen approach (which we shall here term Step 1 level calculations) is to calculate plutonium dosage as though the dose were distributed throughout the entire mass of lung tissue. While it will be shown below (Step 2 calculation) why this is not reasonable, it will suffice for Step 1 calculations. Cohen has used the reasonable value of 570 grams as the lung mass for average man (exclusive of blood). Further, Cohen has applied a factor of 10 for conversion of rad to rem for the alpha-particle radiation of plutonium. The British Medical Research Council Report suggests (p. 10) a value of 10-20 for this conversion. Again, even though possibly not conservative enough, we shall use the Cohen value of 10 for conversion of rads to rems.

To convert microcuries of plutonium deposited to dose in rems, Cohen has used the equation:

Dose in rems/day = 51 EQ/M rems/day-microcurie

where E = energy deposited by alpha radiation in MEV

M = mass of organ in grams

Q = quality factor (the ratio of rems to rads, or the ratio of carcinogenic damage of the Pu alpha particles to that of gamma rays of the same energy).

(E for Pu^{239} = 5.1 MEV; Q = 10; M = 570 grams)

We shall accept all this for Step 1 calculation purposes, except to re-iterate that using M = 570 grams assumes distribution of the dose to the whole lung tissue mass. In Step 2 calculations below, this crucial issue will be treated in detail.

Using the equation above, Cohen arrives at 2000 rems (for that portion of the plutonium presumed to be retained in the lung with a 500 day half-time for removal) per microcurie of deposited plutonium (Pu^{239}). We shall return later to this "500 day half-time for removal", but for Step 1 calculation, the 2000 rems per microcurie will be accepted. Incidentally, since the other Pu nuclides in "reactor-Pu" will have E values not very different from the 5.1 MEV for Pu^{239}, the same calculation will apply per microcurie of other Pu nuclides.

Since we have, above, assigned for the "Cohen" estimate, a value of 25,600 man-rem as the "lung cancer dose", it follows that 1 microcurie of Pu^{239} delivers $\frac{2000}{25300}$, or 0.08 "lung cancer doses".

Expressed otherwise, 1/0.08, or 12.5 microcuries Pu^{239} (For "Cohen" estimates) deposited provide one "lung cancer dose".

In Cohen's paper, he used a risk of "about 4.7 percent" per microcurie instead 8% per microcurie by including the risk for children (erroneously, we believe) and the

804

risk for adults well beyond 30 years of age. Since we are comparing all estimates for adults 20-30 years of age, we have made the minor adjustment in Cohen's estimate back to 8% per microcurie (as per his Figure 2).

Cohen stated, additionally, that of all the plutonium particulates inhaled, only 25% is retained for potential deposition, and he therefore multiplies his "lung cancer dose" by a factor of 4. Since all these discussions relate to deposited plutonium, rather than inhaled plutonium, it is inappropriate to utilize this particular factor of 4. Thus, we shall leave the "Cohen" estimate at 12.5 microcuries deposited Pu^{239} per "lung cancer dose" or per "lung cancer death".

There are 16.3 micrograms of Pu^{239} required to provide 1 microcurie of Pu^{239} alpha radiation. (This is directly calculable from the 24,000 year half-life of Pu^{239}).

Therefore, the "Cohen" estimate becomes

(12.5)(16.3), or 204 micrograms of Pu^{239} deposited per "lung cancer dose".

For "BEIR" estimate, with 5290 man-rems per "lung cancer dose", we calculate $\frac{5290}{2000}$, or 2.65 microcuries Pu^{239} per "lung cancer dose".

Converting to micrograms, 2.65x16.3 = 43.2 micrograms Pu^{239} deposited per "lung cancer dose".

For "Gofman-Tamplin" estimate, with 1310 man-rems per "lung cancer dose", we calculate $\frac{1310}{2000}$, or 0.66 microcuries Pu^{239} deposited per "lung cancer dose".

Converting to micrograms, (0.66x16.3) = 10.8 micrograms Pu^{239} deposited per "lung cancer dose".

All these data are summarized in Table 1.

Table 1

Step 1 Calculation

(assuming distribution of plutonium-239 throughout entire lung mass)

Estimate	Man-Rem per "Lung Cancer Dose"	Micrograms Pu^{239} deposited per "Lung Cancer Dose"
"Gofman-Tamplin"	1,310	10.8
"BEIR"	5,290	43.2
"Cohen"	25,600	204

Cohen has pointed out, correctly, that the mixture of plutonium nuclides from power reactors contains, in addition to Pu^{239}, several shorter-lived nuclides. Therefore, he states, correctly, that reactor-grade Pu is some 5.4 times as hazardous by weight as pure Pu^{239} (as high as 10 times in high burn-up light water-reactor fuel). Taking this 5.4-fold hazard factor into account, we arrive at the estimates in Table 2.

Table 2

Step 1 Calculation

(assuming "reactor-Pu" distributed throughout entire lung mass)

Estimate	Micrograms Reactor Grade Pu per "Lung Cancer Dose"
"Gofman-Tamplin"	2.0
"BEIR"	8.0
"Cohen"	37.8

We are now in a position to make a Step 1 estimate of the "lung cancer doses" per pound of Pu^{239} or per pound of reactor-grade Pu. The reader may well ask "Why calculate per pound of plutonium?" The answer is simply this. For considerations of the hazard posed by a plutonium-based nuclear fission energy economy, we know the number of pounds expected to be in daily commerce, and thus it is well to know the number of "lung cancer doses" involved in such an economy.*

*See Note 2 in "Supplemental Notes"

806

The calculation itself simply involves the number of micrograms per pound and the number of micrograms per "lung cancer dose".

1 pound = 454 grams

or, 1 pound = $4.54 \times 10^2 \times 10^6 = 4.54 \times 10^8$ micrograms.

Illustratively, we may calculate the number of "lung cancer doses" per pound of Pu^{239} in the form of insoluble PuO_2 particles or other finely dispersed insoluble Pu compounds.

From Table 1, for "Gofman-Tamplin" estimates, we have 10.8 micrograms Pu^{239} deposited per "lung cancer dose".

Therefore, "Lung Cancer Doses" per pound of $Pu^{239} = \frac{4.54 \times 10^8}{10.8}$, or 42,000,000 "lung cancer doses".

Similar calculations, for all three estimates, both for Pu^{239} and "reactor-Pu" are presented in Table 3.

Table 3

Step 1 Calculation

"Lung Cancer Doses" per pound of Plutonium

Estimate	"Lung Cancer Doses" per pound Pu^{239}	"Lung Cancer Doses" per pound Reactor-Pu
"Gofman-Tamplin"	42,000,000	227,000,000
"BEIR"	10,500,000	56,800,000
"Cohen"	2,225,000	12,000,000

It must be re-iterated here that all calculations of Step 1 type assume that the plutonium is distributed throughout the entire lung tissue mass. It does not assume uniformity of dose, but rather that the entire lung mass is the distribution region for the plutonium. As will be shown in Step 2 below, this may mean that the estimates of Table 3

represent minimum, rather than probable, estimates of the "lung cancer doses" per pound of plutonium.

Step 2: Analysis of the Nature of the Problem of Non-Uniform Distribution of Plutonium Within the Lung and the Crucial Problem of Which Cells in the Broncho-pulmonary System are involved in Human Lung Cancer Production.

When a population is irradiated by x-rays, gamma-rays, or neutrons, and a dose is properly estimated for lung, we can expect, correctly, that the dose in rems to all segments of the lung-bronchus system is, to a good first approximation, everywhere identical. Under these circumstances it is reasonable to state that 570 grams of lung tissue have been irradiated. Even if some of the tissue (e.g. cartilage, smooth muscle, fibro-elastic support tissue) is not at all involved in cancer production, the dose estimate to the critical tissue susceptible to cancer production is still correct.

For inhaled particulate matter, estimation of the radiation dose as though the particles are distributed into 570 grams of lung tissue can be totally absurd. For example, it is extremely unlikely that any significant part of the inhaled particulates lodges in such tissues as bronchial cartilage, bronchial smooth muscle, walls of pulmonary arterio-venous network, or in fibro-elastic tissue. Therefore, the deposited particulates are distributed into some mass of tissue (including the critical cells for development of lung cancer) much less than 570 grams in mass. How much less? A reasonable first approximation, eliminating cartilage, fibro-elastic support tissue, arterial and venous walls, smooth muscles, and nerves, is that the relevant mass of tissue for distribution of the inhaled plutonium particulates cannot be more than 1/2 of 570 grams. Though this is just a beginning of Step 2 considerations, it immediately permits revision of Table 3 estimates upward by a factor of two. The revised results are presented in Table 4.

Table 4

(Preliminary Step 2 Calculation, based upon 0.5x570, or 285 grams as the Lung Tissue Mass)

"Lung Cancer Doses" per pound of Plutonium

Estimate	"Lung Cancer Doses" per pound Pu^{239}	"Lung Cancer Doses" per pound Reactor-Pu
"Gofman-Tamplin"	84,000,000	454,000,000
"BEIR"	21,000,000	113,600,000
"Cohen"	4,450,000	24,000,000

The Relevant Tissue for Lung Cancer Production

It is well known that the large preponderance of "lung" cancers arise in the bronchi rather than in the parenchymal lung tissue. Indeed it is this preponderance that accounts for lung cancer generally being referred to as bronchiogenic cancer. The BEIR report recognizes this, as does the British Medical Research Council Report. McCallum [27] states that lung cancers are rare in the trachea or the two main-stem bronchi. The cancers are also relatively rare in the bronchioles. So the crucial tissue at risk must be the segmental bronchi, and, within these, the epithelial layer of the bronchi. What is really required is an estimate of the dose delivered by insoluble plutonium particles to this critical tissue, where almost all of the bronchiogenic cancers arise. The British Medical Research Council Report recognized this requirement, but in an apparent zeal for a pejorative analysis of the Geesaman-Tamplin-Cochran "hot particle" thesis, the B.M.R.C. report simply failed to address the most crucial problem of all.

The very fate of human societies may well rest upon this issue, considering the the proposed handling of some 440 million pounds of plutonium (and reactor-grade at that) in the next 50 years in a plutonium-based nuclear fission energy economy.

It is strange indeed that virtually all workers (Cohen, British Medical Research Council, ICRP, and others) have seemed fascinated by the 25% of inhaled plutonium deposited in the tissues beyond the bronchi, when virtually all the cancers arise in the bronchi. It almost seems as though the prevailing mood is that if a serious problem is simply neglected, it may disappear.

The Dose to Relevant Tissue

As will become evident below, it is no simple matter, in the current state of our ignorance, to calculate the true dose from insoluble PuO_2 particles to the relevant bronchial tissue.

All the above-mentioned groups or individuals have made use of a model for lung dynamics developed by a Task Group of the ICRP.[28] This model may be totally irrelevant for the question of exposure of the relevant bronchial cells. What does this model suggest, and where may it fail seriously in the real-life situation?

The model suggests that when PuO_2 particles are inhaled that some 8% deposits in the "tracheo-bronchial" region and some 25% deposits in the deep respiratory tissue ("pulmonary tissue"). It further assumes that the PuO_2 deposited in the tracheo-bronchial region is rapidly cleared into the intestine via the naso-pharynx, with 99% being cleared in less than a day. For the "pulmonary tissue" (tissue beyond the terminal bronchioles), the model suggests that 40% of the deposited PuO_2 is cleared in a day and 40% is cleared with a half-time of some 500 days. The remaining 20% is presumed, in the model, to be cleared via lymph and blood. The 80% (including the 40% rapidly cleared plus the 40% slowly cleared) are presumed to go back up through the tracheo-bronchial system to nasopharynx and thence to intestine.

This model is totally based upon the assumption of normally functioning epithelium of the bronchial system, particularly of normally functioning cilia* to propel the particles

*Cilia are specialized hair-like structures arising from the surface of lining cells, with the function of propelling material.

back up the tracheo-bronchial tree. If that ciliary function is impaired, then all the assumptions concerning clearance rate can be vastly in error, if applicable at all.

While the Task Group of ICRP was quite happy that the model seemed in reasonable accord with experimental animal data on a variety of particulate materials, the model may be irrelevant for humans in real-life circumstances.

Let us recall that most lung cancers (bronchiogenic cancers in man) occur in smokers of cigarettes. Roughly such cancers are 10x as likely in cigarette smokers than in non-smokers. This being the case, we really need to know what the circumstances of PuO_2 deposition and retention will be in cigarette smokers in the population, since this will overwhelmingly determine the bronchiogenic lung cancer effects.

In the extensive studies of lung cancer reported by the Surgeon General, [29] one outstanding set of facts was pointed out, based upon the work of Auerbach et al [30].

(a) There is considerable alteration of bronchial epithelium in cigarette smokers.

(b) There is a serious loss of ciliary presence in cigarette smokers (to say nothing of function of what cilia remain).

If our cigarette smokers have a serious loss of ciliary presence and function, of what use is a model that predicts clearances based upon intact ciliary function? We must face the possibility that, as a result of impairment or loss of ciliary function, PuO_2 deposited in the tracheo-bronchial epithelial region of man may be cleared extremely slowly. Further, the PuO_2 coming back up from the deep pulmonary tissue may also be hung up in the bronchial region, since it is assumed that the ciliary function is what propels it on, ultimately to the intestine.

It will indeed be no easy task to ascertain, for cigarette smoking humans, precisely what the clearance rates are for PuO_2 in human bronchial tissue. But it would

represent the height of public health irresponsibility either (a) to assume that an invalid, irrelevant model provides answers or (b) to neglect the problem simply because it is difficult.

An approach to Estimation of the Plutonium Dose to Relevant Bronchial Cells

There are two parts to this estimate:

(a) Estimation of the fraction of tracheo-bronchial region that is relevant for bronchiogenic cancer.

(b) Estimation of the clearance of PuO_2 particles by bronchial epithelium with impaired ciliary function, as in cigarette smoking humans.

(a) Estimation of the Relevant Part of the Tracheo-Bronchial Region

In the Task Group publication [28] it is estimated that the air volume of naso-pharynx plus tracheo-bronchial region down through terminal bronchioles is 133 cm^3, of which 50 cm^3 is assigned to the nasopharyngeal volume. This leaves 83 cm^3 for the entire tracheo-bronchial region. Since virtually no cancers arise in the trachea, we can subtract approximately 33 cm^3 for the tracheal volume, leaving 50 cm^3. The right and left main-stem bronchi (also rarely involved in cancer) represent a volume of approximately 11 cm^3, so this leaves 39 cm^3 for the bronchial region, including the terminal bronchioles. As a reasonable first approximation, 1/2 of this volume will be assigned to the relevant bronchi, and 1/2 to the volume of smaller bronchial branches plus bronchioles. Therefore, we have, finally, approximately 20 cm^3 for the volume in relevant bronchi. From Gray's Anatomy [31], the diameter of such intrapulmonary bronchi can be estimated as approximately 0.23 cm. (or radius = 0.115 cm.).

Treating these bronchi as cylindrical tubes,

Volume = $\pi r^2 h$, where h = equivalent length of total bronchi of this class

$$20 = 3.14\ (0.115)^2\ h$$

$$\text{or, } h = \frac{20}{(3.14)(0.013)} = \frac{20}{0.04} = 500 \text{ cm.}$$

8/2

To calculate the surface area of such bronchi, we use:

$$\text{Area} = 2\pi r h$$

$$= 2\pi (0.115)\ 500$$

$$= (6.28)(0.115)\ (500)$$

$$= 361\ \text{cm}^2$$

A reasonable approximation for average height of the stratified columnar epithelium of these bronchi is 30 microns, or 3×10^{-3} cm.

Therefore, Volume of Epithelial Tissue = Area x cell layer height

$$= 361 \times 3 \times 10^{-3} = 1083 \times 10^{-3}$$

$$\approx 1\ \text{cm}^3.$$

Since the density of soft tissue is ~1 gram/cm^3, it follows that the mass of relevant bronchial tissue is ~1 gram.

(b) Estimation of the Clearance of PuO_2 Particles by Bronchial Epithelium with Impaired Ciliary Function

The work of Auerbach et al (cited in the Surgeon General's Report on Smoking) shows the following severe losses of cilia in cigarette smokers (Table 5). These were controlled studies in which the pathologist did not know the smoking habits for the cases studied.

The Surgeon General's report comments as follows on loss of ciliary function (Ref. 29, pp 269-270:

> "Inhibition of ciliary motility following exposure to tobacco tars, cigarette smoke, or its constituents has been demonstrated frequently with experimental use of respiratory epithelium from a wide variety of animal species." (17 references quoted).
>
> "Similar results have been obtained with ciliated human respiratory epithelium." (2 references). "Although all investigations have been conducted in vitro, the uniformity of the inhibitory effects in a number of different experimental models is impressive."

Table 5 (Data of Auerbach et al)

Loss of Cilia and Epithelial Cell Abnormality

Group	# Cases	# Slides studied	Percent of slides with cilia absent and averaging 4 or more cell rows in depth.
Never Smoked regularly	65	3324	1.1%
Ex-Cigarette Smokers	72	3436	4.1%
Cigarettes - 1/2 pk/day	36	1824	4.7%
Cigarettes - 1/2-1 pk/day	59	3016	7.9%
Cigarettes - 1-2 pks/day	143	7062	16.9%
Cigarettes - 2+ pks/day	36	1787	37.5%

As noted in Table 5, over and above the loss of cilia there is marked abnormality in the epithelial layer of the bronchi.* Whether these altered epithelial cells may more avidly engulf PuO_2 particles than do normal epithelial cells, either by phagocytosis or endocytosis, is totally unknown. It is possible that the failure of clearance of PuO_2 by such regions may be seriously enhanced over and above the failure of clearance due to the absence of cilia. The Auerbach data reveal the absurdity of the model used by ICRP, by Cohen, and by BMRC for evaluation of PuO_2 clearance by the real population expected to be exposed to PuO_2 inhalation. In the heavy smokers, who will contribute most of the lung cancers, 37.5% of the cells have lost their cilia entirely. We can, therefore, with sound reason, presume that such regions of absent ciliary function will clear PuO_2 particles very slowly, if at all. It would not be at all conservative, for such regions, to assume that the half-time for clearance is 500 days for PuO_2 particles.

*Normal epithelium would show one or two cell rows in depth. Note that Table 5 describes the slides showing four or more cell rows in depth.

814

Quantitative Treatment of Smokers and Non-Smokers For Plutonium Lung Cancer Hazard

Inasmuch as the strong evidence indicates a different physiological handling of PuO_2 particulates for smokers versus non-smokers (henceforth, smokers will be considered to mean cigarette smokers), it is essential to consider these as separate sub-populations. The first step in such separate handling is to re-estimate the risks of lung cancer for smokers versus non-smokers.

For the overall male population (USA), the spontaneous lung cancer rate = 1.27×10^{-3}/year. (P.5, this report). Two subpopulations will be considered as a very reasonable approximation:

1/2 the men as non-smokers

1/2 the men as smokers (all cigarette smokers combined).

Let x = lung cancer rate for non-smokers

and 10x = lung cancer rate for smokers (P.15, this report).

Then, overall rate = (1/2) (x) + 1/2 (10x) = 1.27×10^{-3}

$$\text{or,} \quad \frac{11x}{2} = 1.27 \times 10^{-3}$$

$$x = 0.23 \times 10^{-3}/\text{year}$$

$$10x = 2.3 \times 10^{-3}/\text{year}$$

With these evaluations of (x) and (10x), it is possible to convert all tables presented above into separate tables for smokers and for non-smokers. Wherever risks are involved, values for smokers (compared with overall population) must be multiplied by $\frac{2.3 \times 10^{-3}}{1.27 \times 10^{-3}}$ or a factor of 1.81 .

Values for non-smokers (compared with overall population) must be multiplied by $\frac{0.23 \times 10^{-3}}{1.27 \times 10^{-3}}$ or a factor of 0.181.

Table 3 can now be converted to one which treats smokers and non-smokers separately. These converted data, utilizing the factors above (1.81 and 0.181), are presented in Table 6.

Table 6

Step 1 Calculation: Separate Data for Smokers and Non-Smokers

Lung Cancer Doses per Pound of Plutonium*

For Cigarette Smokers:

Estimate	"Lung Cancer Doses" per pound Pu^{239}	"Lung Cancer Doses" per pound Reactor-Pu
"Gofman-Tamplin"	76,000,000	411,000,000
"BEIR"	19,000,000	103,000,000
"Cohen:	4,030,000	21,700,000
For Non-Smokers:		
"Gofman-Tamplin"	7,600,000	41,100,000
"BEIR"	1,900,000	10,300,000
"Cohen"	403,000	2,170,000

*Note: This is still a Step 1 calculation assuming plutonium distributed into the entire 570 grams of (bloodless) lung tissue mass.

Step 3 Calculations of Lung Cancer Hazard from PuO_2 for Smokers and Non-Smokers

(a) The Cigarette Smokers:

As a result of the presence of large regions of cilia-free bronchi, coupled with potentially impaired ciliary function in additional regions, it is highly reasonable to estimate that clearance from cilia-free bronchial regions will be comparable with that estimated for cilia-free pulmonary regions. This leads to $T_{1/2}$ = 500 days for clearance for such cilia-free regions. From Table 5, cigarette-smokers of more than 1 pkg. per day average ~25% cilia-free regions.

Therefore, if we assume 25% of bronchi will show impaired clearance, we can hardly be overestimating the effect. It may not be conservative enough.

In the ICRP Task Group Model it is assumed that

25% of inhaled PuO_2 deposits in pulmonary tissue

8% of inhaled PuO_2 deposits in tracheobronchial region.

It is further assumed by ICRP that only 60% of the PuO_2 deposited in pulmonary tissue is retained for long-term clearance and that none of the PuO_2 deposited in the tracheobronchial tree is retained for long-term clearance.

With impaired ciliary clearance for 25% of the bronchial region, we shall assume

(a) that 25% of that deposited in tracheobronchial tree is subject to retention. 25% of 8% = 2% of total. Moreover, we shall use ICRP's estimate that 40% of this clears within a few days, leaving 0.6x2 = 1.2% for long-term retention.

(b) Further, of the 40% coming up rapidly (as per ICRP) from the pulmonary region that 25% of this 40% is retained in the bronchial region. 25% of (40% of 25%) = 2.5% is retained, additionally, of which 60% is retained long-term. Long term, therefore = 1.5%. Therefore, total retained for long-term clearance becomes

1.2 + 1.5 = 2.7% in bronchial region.

The ICRP Model allows 60% of 25%, or 15%, of total to be retained in pulmonary region, providing dose to this region.

Since we have just calculated 2.7% to be retained in the bronchial region, it follows that the bronchial region has a radiation source = $\frac{2.7}{15}$, or 0.18 as strong as the pulmonary region.

But to estimate dose to bronchial region, we must also incorporate the estimated tissue mass (bronchial) irradiated. This was shown above to be one gram.

Therefore, the overall radiation dose to bronchial region

= $(0.18) \times \frac{(570)}{1} \times$ (Dose to pulmonary region)

= (103) x (Dose to pulmonary region).

817

This dose, in the cigarette smokers, will completely dominate the additional dose received by the pulmonary region.

It is now possible to estimate the lung cancer doses per pound of PuO_2 by applying this factor of 103 as a multiplier for all the values for smokers in Table 6. The results of this calculation are presented in Table 7.

Table 7

Step 3 Calculation: Final Estimate of PuO_2-induced Lung Cancers in Cigarette Smokers

Estimate	"Lung Cancer Doses" per pound Pu^{239}	"Lung Cancer Doses" per pound Reactor-Pu
"Gofman-Tamplin"	7,830,000,000	42,300,000,000
"BEIR"	1,960,000,000	10,600,000,000
"Cohen"	415,000,000	2,240,000,000

The number of micrograms Pu per lung cancer dose is now readily estimated for the cigarette smokers. For example, from Table 7, the Gofman-Tamplin estimate is 7,830,000,000 lung cancer doses per pound Pu^{239}.

$$1 \text{ pound} = 4.54 \times 10^8 \text{ micrograms}$$

$$\text{Therefore, } \frac{7.83 \times 10^9}{4.54 \times 10^8} = \text{lung cancer doses per microgram.}$$

The micrograms per lung cancer dose is the reciprocal, or $\frac{4.54 \times 10^8}{7.84 \times 10^9} = 0.058$ micrograms. In a similar fashion all the values of Table 7 can be treated to provide the estimates of Table 8.

Table 8

Final Step 3 Estimates of Micrograms Pu per Lung Cancer Dose in Cigarette Smokers

Estimate	Micrograms Pu^{239} per lung cancer dose	Micrograms Reactor-Pu per lung cancer dose
"Gofman-Tamplin"	0.058	0.011
"BEIR"	0.23	0.043
"Cohen"	1.10	0.203

(b) The Non-Smokers

For this population sub-group, the Auerbach data (Table 5) show the following:

Never Smoked Regularly: 1.1% of bronchial regions show cilia absent.

Ex-Cigarette Smokers: 4.1% of bronchial regions show cilia absent.

We shall weight the "never smoked" twice as heavily as the ex-cigarette smokers and arrive at a value of 2% as an average for bronchial regions showing cilia absent in a cross-section of non-smokers.

For the cigarette smokers, a value of 25% was used above for the bronchial regions showing ciliary absence. Therefore, we arrive at the estimate that, whatever dosage of the relevant bronchi is taken for cigarette smokers, the appropriate value for non-smokers is 2/25, or (0.08) of that dosage. The number of expected lung cancers from plutonium inhalation in non-smokers will therefore be(0.008)x(lung cancers expected in smokers). (0.08 for source strength and 0.1 for cigarette-lung cancer risk.)

Accordingly, Table 9, providing lung cancer doses per pound of Pu for non-smokers is derived from Table 7 by multiplying all values by (0.008).

Table 10, providing micrograms Pu per lung cancer dose, is derived from Table 8 by dividing all values by (0.008).

Table 9

Final Step 3 Estimates of PuO_2 Induced Lung Cancers per Pound in Non-Smokers

Estimate	Lung Cancer Doses per pound Pu^{239}	Lung Cancer Doses per pound Reactor-Pu
"Gofman-Tamplin"	62,600,000	338,000,000
"BEIR"	15,700,000	85,000,000
"Cohen"	3,300,000	17,900,000

819

Table 10

Final Step 3 Estimates of Micrograms Pu per Lung Cancer Dose in Non-Smokers

Estimate	Micrograms Pu^{239} per lung cancer dose	Micrograms Reactor-Pu per lung cancer dose
"Gofman-Tamplin"	7.3	1.4
"BEIR"	28.8	5.4
"Cohen"	138.0	25.4

In the treatment here, both for smokers and non-smokers, no crediting was given to diminished ciliary function over and above ciliary absence. It is quite possible that we have underestimated the hazard of plutonium inhalation as a result. Nevertheless, the preference is to understate the hazard wherever data are not absolutely firm, provided all concerned realize that there may well be an understatement.

GENERAL DISCUSSION

Are the Estimates Too High or Too Low?

It is evident from all the discussion up to this point that certain key parameters of physiological function are not available through direct experimental evidence for humans. One fact, however, is outstanding—that is the failure of authoritative bodies such as ICRP or BMRC to come to grips with the real-life problem of bronchopulmonary retention of PuO_2 particles in cigarette-smoking humans. This failure has led them to the use of a totally unrealistic and probably irrelevant model which drastically underestimates the lung cancer hazard of PuO_2 inhalation. One may ask whether the retention in bronchial tissue, secondary to loss of ciliary function, will really lead to a 500-day half-time for clearance of PuO_2 particles. We simply don't know, but it is just as reasonable to expect an even longer retention time as it is to hope for a shorter retention time. Since ciliary function is the mechanism counted upon for differentiating rapid clearance in the bronchi versus slow clearance in the pulmonary region, the absence of effective ciliary function makes it reasonable, as a first approximation, to expect clearance times to become identical.

If there be any intrinsic more rapid clearance mechanism (aside from cilia) for bronchial cells than for pulmonary cells, such mechanism is totally hypothetical. Indeed, the effect can be such as to worsen the estimates.

One may ask whether the metaplastic and hyperplastic epithelium of the bronchi of cigarette-smoking humans is more or less active in the engulfing of PuO_2 particles than is the normal epithelium. We simply don't know, but it is, a priori, equally probable that such epithelium can be less, equally or more active in engulfing PuO_2 particles. The burden of proof that metaplastic and/or hyperplastic epithelium is less active in engulfing PuO_2 particles would rest upon those who think it may be less active. From what we know about the general physiology of injured or inflammatory tissue, the expectation, if anything, is for greater phagocytic activity, not less. And this would make the PuO_2 carcinogenicity worse than calculated, not better.

The Hazard of Dispersal of Plutonium Oxide Aerosols

Cohen endeavored to show that plutonium dispersal was not as bad as general opinion has held it to be. The seriousness of his under-estimate of the cancer hazard of inhaled PuO_2 aerosols is evident in this report. Thus, comparison of Cohen's 2,225,000 lung cancer doses per pound of Pu^{239} (Table 3) with the final "Gofman-Tamplin" estimate of 7,830,000,000 for cigarette-smoking humans, shows that Cohen is low by a factor of $\frac{7,830,000,000}{2,225,000}$, or 3520 times too low. Even for the non-smoker, his estimate is some 30 times too low.

In view of these serious under-estimates of the lung cancer hazard from inhaled Pu, most of his estimates of the hazard of plutonium dispersal will require scaling up by a factor of 3520 times.

Cohen, in his general thesis that plutonium, while very toxic, is not as toxic as many have thought, presented a calculation that insoluble reactor grade Pu is roughly

821

60 times more carcinogenic than benzpyrene. Benzpyrene is a now-famous substance, being one of the most potent chemical hydrocarbon carcinogens known. If we correct Cohen's estimate by the 3520 fold factor required, his estimate would then be that reactor grade Pu is roughly 211,000 times as carcinogenic as benzpyrene for smokers. It would seem that this revision would materially enhance the carcinogenic stature of plutonium for Cohen.

In consideration of "lung cancer doses" per pound of plutonium it must be recalled that this reflects the expected number of fatal lung cancers per pound of deposited plutonium. The question of how much of dispersed PuO_2 actually gets deposited is a wholly separate issue, based largely upon meteorology and dispersal conditions. Thus, if plutonium is dispersed and falls out over the ocean, there are few humans around to inhale it, so very few of the cancers can occur. On the other hand, dispersal with fallout in a city can lead to very drastic consequences in lung cancer fatalities.

It has been estimated that the nuclear weapons testing of the 1950s and 1960s has resulted in the worldwide fallout of some 11,500 pounds of plutonium-239 equivalent.[35] Some have suggested that if plutonium is so virulent a carcinogen as it appears to be, why haven't more cases of lung cancer occurred as a result of this fallout? The author has calculated the consequences of this plutonium fallout, and these consequences will be presented in a separate report.[32] Huntington has repeatedly raised the question of whether the increasing epidemic of lung cancer may be, in part, due to plutonium fallout.[33] Huntington may well have raised one of the most crucial public health issues of our time.

Comparison of Human Data with Experimental Beagle Data

The British Medical Research Council Report has reviewed the beagle dog studies of Bair and Thompson.[34] The initial depositions were between 3 nanocuries

and 50 nanocuries of Pu-239 per gram of bloodless lung. Even at the lowest level (3 nanocuries per gram of lung), essentially 100% of the dogs died of lung cancer. We know, therefore, that 3 nanocuries per gram of bloodless dog lung is at least one "lung cancer dose". As BMRC pointed out, the true "lung cancer dose" could be much lower, and on-going experiments at lower doses will be required to test this issue.

But, there are sufficient data already to compare the beagle evidence with the human calculations presented in this report.

3 nanocuries per gram = 3×10^{-3} microcuries per gram.

To scale to human, with a 570 gram bloodless lung we have

$3 \times 10^{-3} \times 570$, or 1710×10^{-3}, or 1.7 microcuries of Pu-239 is at least one "lung cancer dose".

Conversion to micrograms, $1.7 \times 16.3 = 27.1$ micrograms of Pu-239 is at least one "lung cancer dose".

In Table 8, "Gofman-Tamplin" estimates are that 0.058 micrograms is the lung cancer dose for cigarette smoking humans, and in Table 10, the similar estimates are that 7.3 micrograms of Pu^{239} is the lung cancer dose for non-smoking humans.

Curiously enough it has been overlooked that beagle dogs raised in laboratories are not in the habit of smoking cigarettes. If a relevant comparison is to be made with humans, the appropriate treatment would be to compare the beagle data with the estimates for non-smoking humans.

Let us compare these values directly:

For the beagle dog (a non-smoker): 27.1 micrograms Pu^{239} is at least one lung cancer dose.

For the human (non-smoker): 7.3 micrograms Pu^{239} is one lung cancer dose.

As the BMRC report pointed out, virtually 100% of the beagles developed lung cancer at 3 nanocuries per gram of bloodless lung. It would be in the realm of miracles that the 3 nanocuries/gram happened to coincide with one lung cancer dose. In all likelihood, the true lung cancer dose for non-smoking beagle dogs is lower than 3 nanocuries per gram, and quite possibly considerably lower, just as was pointed out by the British Medical Research Council Report. Since the beagle data are even now so close to the estimates calculated here, it seems virtually certain that the newer beagle data will not be significantly different from the human estimates.

The Standards for "Permissible" Exposure to Plutonium, Occupational and for the Public-at-Large

The existing guidelines for "permissible" exposures to plutonium particulates permit:

(a) Occupational workers: Maximum lung burden = 0.016 microcuries.

(b) Public-at-Large: Permissible burden for the average person = 0.0005 microcuries.

Tamplin and Cochran[1], at the time of releasing their report, stated that the current guidelines make it extremely likely, indeed almost certain, that exposed individuals (occupationally-exposed) would develop fatal lung cancers.

It is of interest to test this prediction of Tamplin and Cochran against the calculations of this report, calculations that in no way depend upon the hot particle approach utilized by Tamplin and Cochran.

Predictions for Occupational Exposure

Since 16.3 micrograms represent 1 microcurie of Pu^{239}, the occupational permissible burden of 0.016 microcuries represents 0.26 micrograms of Pu^{239} equivalent.

For Cigarette-Smoking Workers:

1 lung cancer dose = 0.058 micrograms (Table 8). Therefore, each worker is permitted to acquire a lung burden of $\frac{0.26}{0.058}$, or 4.5 lung cancer doses. Since it only takes one lung cancer to kill a human, it is something of an overkill to guarantee 4.5 fatal lung cancers per worker. For these workers, therefore, we not only agree with Tamplin-Cochran, but we believe they understated the hazard.

For Non-Smoking Workers:

1 lung cancer dose = 7.3 micrograms (Table 10). Therefore, each worker is permitted to acquire a lung burden of $\frac{0.26}{7.3}$, or 0.036 lung cancer doses. Therefore, the expectation is that approximately one such worker out of thirty would develop fatal lung cancer at the permissible dose.

Predictions For the Public-at-Large

The implications of this report's calculations for the public-at-large are much more startling. The permissible average burden of 0.0005 microcuries of Pu^{239} corresponds to 0.0082 micrograms of Pu^{239} equivalent.

The population of the USA is roughly 1/2 non-smokers, 1/2 cigarette smokers. Since there are some 10^8 males per generation, at the current US population size, there are 5×10^7 cigarette smokers and 5×10^7 non-smokers.

Total lung cancer doses, for cigarette smokers,

$$5 \times 10^7 \times \frac{0.0082}{0.058} = 5 \times 10^7 \times 0.14 = 7 \times 10^6 \text{ lung cancer doses.}$$

Total lung cancer doses, for non-smokers,

$$5 \times 10^7 \times \frac{0.0082}{7.3} = 5 \times 10^7 \times 0.0011 = 0.06 \times 10^6 \text{ lung cancer doses.}$$

Combining these, we have 7,060,000 extra fatal lung cancers that can be expected in USA males per generation if the population exposure to plutonium approached that which regulations now permit.

Since these lung cancers would occur over a 30-year period, the expectation would be for $\frac{7,060,000}{30}$, or 235,000 extra fatal cancers per year in men. Since the current lung cancer fatality rate, from all causes combined, is 63,500 per year in men, the conclusion must be drawn that governmental regulatory bodies are not disturbed over causing an additional four times as many lung cancer deaths as are now occurring.

Many serious public health experts consider 63,500 lung cancer fatalities per year to represent a most serious epidemic. How should they view the burgeoning plutonium-based nuclear fission energy economy, proceeding under regulatory standards that would permit a four-fold increase supplementary to this epidemic?

Supplemental Notes

Note 1: The BEIR relative risk percentage refers to adults. If it were restricted to 20-30 year old adults, the BEIR value might have to be increased even further than the 0.5% value used in this report (for BEIR). This entire present report, for consistency, compares all estimates for males in the 20-30 year age range (see p.3, this report).

Note 2: Calculation of fatal doses per pound of a toxic material of commerce may, at first glance, appear to represent an effort to exaggerate toxicity. This is incorrect. Indeed, it will be quite relevant, in the future, to describe all industrial pollutants in a similar manner. For substances handled in commerce in pound or ton quantities, a rational reference framework will be to require toxic or fatal doses per pound.

Some observers have pointed out that society has handled many highly toxic non-radioactive pollutants in pound or ton quantities. Since, in general, no careful followup studies have ever been made for most such pollutants, it may well be that a societal reappraisal of such non-radioactive pollutants is urgently indicated.

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Particularly, the following one of this series:
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ADDRESS REPLY TO
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75-1672
n-578

July 25, 1975

BY HAND

John F. Shea, III, Esq.
Assistant Attorney General
State of New York
Department of Law
Two World Trade Center
New York, New York 10047

Re: The State of New York v.
The Nuclear Regulatory Commission,
et al. (75 Civ. 2121 WCC)

Dear Mr. Shea:

As I previously advised you, I have delayed in responding to your letter of July 17, 1975, to Judge Conner in order to await the response of the Nuclear Regulatory Commission (the "NRC") to an identical inquiry from Congressman Scheuer of New York.

On May 7, 1975, we made a commitment to the Court to notify your office of any air shipments of significant quantities of special nuclear materials going into or out of New York airports until an evidentiary hearing on your motion for a preliminary injunction was held. Significant quantities of special nuclear materials were defined as over two kilograms of plutonium or uranium 233 and over five kilograms of uranium 235. You are correct that a shipment by an NRC licensee of approximately 45 kilograms of high enriched uranium 235 was transported by truck last week to JFK Airport and from there flown to Germany aboard a World Airways aircraft. It was due to inadvertence that your office was not notified of this shipment for which I appologize.

Your claim that this shipment emphasizes the need for the preliminary injunction you seek is puzzling

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and without merit for two reasons. First, the primary focus of this lawsuit has been the safety of transporting special nuclear materials by air. One of the most significant things which has happened since the May 7 conference is the plaintiff's admission that there is no radiological hazard in shipping enriched uranium by air, regardless of the degree of enrichment. (Gofman Affidavit, para. 4, submitted in support of plaintiff's motion). Thus plaintiff has conceded that there was no danger even if the enriched uranium which was flown from JFK Airport last week had been released in an aircraft accident.

Secondly, the persons you represent knew of this shipment even before it reached the airport. I have been informed that the New York City Department of Health was notified, pursuant to its regulations, by the licensee that the uranium was to be transported through New York City and that the airline notified a Port Authority official at JFK on July 8 that the materials were to be flown out of JFK Airport. In fact, I was told that Dr. Leonard Solon of the New York City Department of Health met the truck transporting the uranium at the George Washington Bridge before it even entered the City. I was informed that he had the truck stopped sometime before midnight of July 8 and that it was prevented from proceeding until approximately 5:00 a.m. on the morning of July 9.

Until your motion for a preliminary injunction is decided, we will make every attempt to notify you of air shipments of which we are aware involving significant quantities of special nuclear materials going into or out of New York airports. As you know, the NRC does not specify the mode of transportation to be used by its licensees and present NRC regulations do not require licensees to notify it of the time, mode or route of a shipment. NRC has under consideration a proposed rule that will require such advance notification of shipments of significant quantities of special nuclear materials. Pending final action on this proposal, NRC

has requested that licensees give such notification to the NRC and licensees have been cooperating. We will convey such information to you when a New York airport is involved.

We will also tell you of similar, non-military shipments by the Energy Research and Development Administration ("ERDA") or by independent shippers transporting special nuclear materials for ERDA. As to the latter, the usual practice has been to leave the mode of transportation to the shipper. Because of our commitment, these shippers have been asked to inform ERDA in advance of air shipments involving New York airports.

Obviously we cannot and are not warranting that we will inform you of every shipment by air through a New York Airport for we may not be informed of some. You would therefore be wise, if you have not already done so, to ask New York City and the Port Authority to give you similar notification. Their regulations, unlike NRC's regulations and ERDA's practice, do require advance notice and they may therefore know of shipments of which neither ERDA nor the NRC are informed.

Except as NRC licensees or ERDA shippers are required to notify state or local officials, information about shipments of special nuclear material is treated as confidential by these agencies and should be so treated by your office. Of course, you may inform the Court under seal of such shipments if you wish. Please send me a written confirmation that you will keep such information confidential.

It is also incumbent upon your office to ensure that shipments of special nuclear materials which conform to established law and regulations travel through New York State without any difficulty. Both of the shipments that I know of since the May 7 conference were subjected to harassment. These were last week's shipment which Dr. Solon tried to stop and the shipment of less than one ounce of

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plutonium, mentioned in my June 10, 1975 letter to Judge Conner, which I was told the Fire Marshal at JFK Airport tried to prevent.

You should inform the relevant state and local authorities that they have no basis at this time for interfering with shipments in interstate commerce of special nuclear materials traveling in accordance with law. We expect you to make every effort to put an end to all such unlawful interference in the future.

Very truly yours,

PAUL J. CURRAN
United States Attorney

By: Charles Franklin Richter
CHARLES FRANKLIN RICHTER
Assistant United States Attorney
Telephone: (212) 791-1977

cc: Honorable William C. Conner
United States District Judge
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mbbr

UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF NEW YORK

STATE OF NEW YORK,

Plaintiff,

-against- : 75 Civ. 2121(WCC)

NUCLEAR REGULATORY COMMISSION, et al.,

Defendants.

Before:

HON. WILLIAM C. CONNER,

District Judge

New York, July 25, 1975
Room 3006 - 2:15 p.m.

APPEARANCES:

LOUIS J. LEFKOWITZ, Esq.,
Attorney General of the State of New York,
Attorney for Plaintiff,
Joseph J. Zedrosser, Esq., and
John F. Shea, III, Esq.,
Assistant Attorneys General

PAUL J. CURRAN, Esq.,
United States Attorney for the
Southern District of New York,
Attorney for Defendants,
Charles Franklin Richter, Esq., and
Nathaniel L. Gerber, Esq.,
Assistant United States Attorneys

- - -

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THE COURT: I understand that the defendant wanted to make some motion. What are they?

MR. RICHTER: That is correct, your Honor. The defendants wished to seek the dismissal of the Civil Aeronautics Board, the CAB, and the Customs Service from this case. We tried to work this out by agreement with the state, but the state did not agree to the dismissal of these parties.

We also feel compelled to move for the dismissal at this time particularly as to the CAB, because, since we are being forced to provide an answer, as the plaintiff is entitled to receive, we feel it's important to point out that this court does not have jurisdiction over the CAB, and that the CAB should be dismissed.

The plaintiff seeks a declaratory judgment that air transportation of plutonium without an environmental impact statement is in violation of NEPA and the plaintiff also seeks in its complaint a permanent injunction nulling and setting aside all present and future actions permitting air transportation of plutonium.

As far as the CAB is concerned, 49 USC Section 1486 provides that any order, affirmative or negative, of the CAB shall be subject to review by the Court of Appeals or by the Court of Appeals of the District of Columbia.

Insofar as plaintiff, in any conceivable way, is seeking the annulment of any prior CAB order which the plaintiff might claim permits the ait transportation of plutonium, then the plaintiff should be in the Court of Appeals.

Secondly, the plaintiff has failed to exhaust its administrative remedies with respect to the CAB. There is nothing in the record indicating any appeal or request on behalf of the plaintiff to the CAB. In addition to the jurisdictional ground, the CAB is in no way involved in regulatingthe air transportation of plutonium, nor is Customs. The purpose of the CAB is the economic regulation of aircraft. It does not license any particular cargo of aircraft. Safety regulations with respect to aircraft is left entirely to the FAA.

For Customs, the case is even more obvious. The only thing that Customs does is that when special nuclear materials come into the United States or leave the United States, when they are being brought in or exported by NRC licensees, it checks to see whether there is a license, and it checks to see that the regulations of other governmental agencies have been complied with. That's all they do. They are in no other way involved in regulating the transportation of these materials. We therefore see

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absolutely no basis upon which the CAB or Customs has to prepare an environmental impact statement, which is the center of the plaintiff's lawsuit.

We would also point out we see no way in which the plaintiff would be harmed by the dismissal of either the CAB or Customs from this lawsuit, since the primary parties are the NRC, which licenses the handling of special nuclear materials, and ERDA, which produces and also transports on its own special nuclear materials, and therefore the plaintiff could get all of the relief that it seeks by just seeking a relief against the other five defendants which would remain in the lawsuit.

THE COURT: Mr. Zedrosser, why do you need the CAB and the Customs Service in the lawsuit?

MR. ZEDROSSER: We joined them because, as alleged in our complaint, which has never been ~~entered~~ answered by defendants, they do have involvement in the shipment of these materials. Specifically on the CAB, we have indicated and it has never been denied, that they do have safety responsibilities. The fact of the matter is that the business about Court of Appeals review is simply not applicable here. The section to which Mr. Richter refers refers to review of orders of the CAB. I don't know of any order of the CAB. The Court of Appeals is not the place

to go, and we didn't go there.

THE COURT: No, I don't place much weight in the argument about going to the Court of Appeals for review of orders of the CAB, but I am concerned with respect to his argument that nuclear materials are shipped in and out every day without the CAB's even knowing about it.

MR. ZEDROSSER: If that's so, that is in derogation of their statutory responsibilities, because as we have indicated in Paragraph 10 of our complaint, that body is charged with the regulation of air transportation in a manner which will insure the highest degree of safety in air transportation, and is further charged with the promotion of safety in air commerce.

THE COURT: That is not the point. If in fact nuclear material can come into the New York airports and leave from the New York airports under the present setup without anybody's having to apply to the CAB for permission, enjoining the CAB from granting permission is not going to do any good.

You are asking me then to direct the CAB to exercise a jurisdiction in connection with these shipments which it doesn't appear to be necessary, because if I direct the NRC and the ERDA to do so, isn't that sufficient? Why is it necessary to make a similar directive with respect to the

CAB?

MR. ZEDROSSER: First of all, because of the statute that the Congress has passed, which says they should be doing this.

Secondly, I don't think that even if this were a belt and suspender operation, that that would be inappropriate. Mr. Richter has pointed out in his letter that sometimes one agency or the other may not know about a shipment, even NRC, until too late.

THE COURT: Why not include Congress? Congress has the responsibility for regulating. Why not bring them in? How about the president? Bring him in because he has responsibilities in the field of interstate commerce as well.

MR. ZEDROSSER: This is by statute, your Honor. Congress acted and said that the CAB had this responsibility. Moreover, we think that they may well have responsibilities under NEPA. That is what we argue in our complaint.

THE COURT: But there are statutes that say these shipments have to be regulated by NRC. That is where the primary responsibility lies. Everybody is required, as I understand it, to go to NRC for a permit to move these materials, and if NRC is enjoined, then it seems to me that you don't need any more.

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MR. ZEDROSSER: Of course, that leaves various shipments -- I assume the Court means NRC and ERDA.

THE COURT: Yes, and ERDA. If you get to them, you have gotten everybody who has been charged with the responsibility of permitting or approving such shipments.

MR. ZEDROSSER: Your Honor, we certainly are not going to consent to the dismissal. We believe we had a fair basis in law to join them in the first place. I might also add, and this relates to the question of default to answer as well, we certainly feel aggrieved as to that default. Mr. Richter almost makes it sound like we are imposing on them to answer the complaint here. It is, after all, the federal rules that require the answer, and not some strange plaintiff with some strange ideas.

THE COURT: The complaint should have been answered.

MR. ZEDROSSER: So we are not consenting to the late filing of anything, but I might add that if they are permitted to file anything, to be allowed now three weeks in default, to first file a motion to dismiss as to certain defendants, not then having to answer as to those defendants until the resolution of the motion is adding insult to injury. At the very least --

THE COURT: Have NRC and ERDA answered?

MR. RICHTER: They have not, your Honor.

THE COURT: They have not. How soon can they answer?

MR.RICHTER: They can answer by a week from today, your Honor.

THE COURT: All right, I will direct that within one week from today NRC and ERDA will file their answer and the other defendants who intend to move to dismiss will do so by that time.

MR.RICHTER: Your Honor, since it appears that now we will have to prepare extensive papers on this point of dismissal, may we ask that we have two weeks from today in which to putin the answer and the motion to dismiss?

THE COURT: All right.

MR. ZEDROSSER: Your Honor, if I may be heard briefly, first of all, as I understand it, the only two defendants as to which they wish to move to dismiss are the CAB and the customs, so tha leaves NRC, FAA, DOT and State, if I have ticked them off, which gives them no reason not to answer --

THE COURT: Everybody will answer who is not moving to dismiss.

MR. ZEDROSSER: No. 2, I see no reason as to why those two others, CAB and Customs, why they cannot answer,

and have us join issue finally, three months after the papers have been served, and if they want to move to dismiss, they can do it after that on the pleadings, so that we can go on without holding up this case. I think it's outrageous to make use of this provision which allows further delay of an answer when we are talking about the three paragraphs of a ~~six paragraph~~ sixteen page complaint that specifically deal with those defendants. It's not an onerous burden.

THE COURT: It's not as simple as you make out. I haven't the slightest doubt that with the most minor modifications and supplements the answer filed by CAB and Customs would be identical to the answer filed by everybody else, so as long as you get the answer of all the remaining defendants by a week from today I don't think you will be seriously prejudiced by the fact that CAB and Customs are filing a motion to dismiss instead of an answer.

MR. ZEDROSSER: Your Honor, to be a little bit more responsive to the Court's question on the merits, I should also point out that we shouldn't overlook that the CAB licenses international carriers. It seems to me that they are in a prime position to enforce any proper rule about the transportation of special nuclear materials. I think that the effectiveness of our remedy will be

greatly enhanced by the joining of the CAB and even Customs can initiate a program where the policy of non-shipment can be made known to people before they try to bring it over here. I think these things are important.

THE COURT: If Customs and CAB are not in a position where they are receiving information about shipments, they are not monitoring shipments, there is no reason to enjoin them at all, and insofar as enforcing the Court's order, if you get an injunction prohibiting the shipment which runs into NRC and ERDA and FAA and DOT, you will have to leave it up to the Court to see that the injunction is enforced, and adding CAB and Customs to it is not going to add any real muscle to the injunction.

If you get the injunction you are seeking, it will be enforced, don't worry about it.

MR. ZEDROSSER: Your Honor, it may be appropriate at this time to advert to the letter that we sent to the Court which arrived late yesterday in which we asked that if the Court should be unable to make whatever determination it deems appropriate on the papers before it prior to the up and coming vacation, that this case be reassigned.

As we indicated in the letter in somewhat different but still similar context some time ago, the Court had mentioned that perhaps Judge Frederick van Pelt Bryan

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might be able to undertake the case. We think the suggestion then is if anything even more appropriate now, but th if he would not, for whatever reason, be able to do it or be willing to do it, that under Rule 4-C of the individual assignment and ~~the~~ calendar rules of this court, that the assignment committee be asked to reassign the case for a prompt determination of this preliminary injunction motion.

THE COURT: If I had the slightest reason to believe that reassignment would get you a quicker decision, I would be the happiest man in the world to get the case reassigned, but we are living in a real world, Mr. Zedrosser, and not a dream world. This is the last month in July. At this moment there are probably not more than eight of the District Court Judges on the premises at Foley Square, and for the first two or three weeks in August, there will be substantially fewer than that. There will be one judge who is in Part I, and I can assure you, having just gone through a couple of weeks in Part I and having a week left to go, that he is not going to have time to consider these voluminous papers and to render a decision while he is sitting in Part I.

In early September there is a judicial conference, and some of the Judges will not be coming back to Foley Square until after the judicial conference.

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If you can find me a judge who says, "I am going to be here, and I will have the time to consider this matter," I will virtually commit to you now that I would assign it to him with alacrity and with relief, but I have not the slightest reason to believe that there is any such possibility.

We had a conference on this in early July, July 3rd, as I recall. At that time, this Court was in its crash program where every Judge in the court was committed to putting his full time in to the trial of cases more than three years old, and was expressly enjoined to spend no time on anything else, including this matter.

That program ended on the 11th of July. Immediately after that I went into Part I and have been in Part I ever since, and with a lot of Judges gone, I have had all of their emergency matters in addition to all the routine matters that regularly come into Part I.

I regret that you haven't gotten action as quickly as you would like, but I assure you that it is not because I have been sleeping.

MR. ZEDROSSER: Well, your Honor, obviously it is not within the power of your Honor personally to corral some other Judge and have him take it. I make no such claim.

All we are saying is it does seem to be an assignment committee procedure which the Court has set up.

THE COURT: There is such a procedure, and if I reassign it to the assignment committee, the chief of the assignment committee is gone at the moment, but assuming that he would come back and to call a special meeting of the assignment committee for the benefit of your clients and reassign the case, and that all of this happened in the shortest conceivable time, that is, within a week, it would go to a new judge who wouldn't even be here perhaps for two or three weeks, and by the time he started afresh on the matter, you would be extremely lucky if you could get a decision on a matter of this weight and importance before the second week in September, considering vacations and considering the judicial conference.

If you can suggest a practical scheme for accelerating this, I will be happy to consider it, but reassigning it to the assignment committee, much as I would like to do it, is not going to get you a quick decision.

MR. ZEDROSSER: I gather that the Court's suggestion about Judge Bryan didn't materialize for some reason?

THE COURT: He refused to take it. He said that

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FOLEY SQUARE NEW YORK N.Y. - 791-1020

he was fully committed on other matters. He said he would like to take it, but that he had other commitments that would keep him busy right up to the time he was supposed to leave on vacation.

MR. ZEDROSSER: Apropos of the comment the Court made about the investment of time that a new Judge would have to make, has the Court had an opportunity to read all the affidavits at this point yet?

THE COURT: No, I haven't, simply because I have had other things that I had to do. I haven't had as much free time in Part I as I had hoped I might have.

MR. ZEDROSSER: I am loathe to even appear to be pressing the Court as much as I suppose I am, but is there any kind of time that the Court can indicate that it will be able to get to this?

THE COURT: I can't give you any assurance. I wish you could sit here and see what co[illegible] across a Judge's desk in Part I.

MR. ZEDROSSER: As the Court knows, I used to have a criminal practice here, and I used to appear in Part I, and I know that --

THE COURT: You didn't get the full flavor because --

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. 791-1020

MR. ZEDROSSER: Probably not.

THE COURT: -- every hour it's some new temporary restraining order. Yesterday afternoon it was the provisional employees at Gouveneur Hospital who fear they ae going to be laid off and want a temporary restraining order that prevents them from being bumped by employees having seniority who are being laid off at other hospitals that are being closed.

There is something like that coming up almost every hour, and everyone's complaint is a matter of extreme urgency to him, at least, just as yours is to you.

MR. ZEDROSSER: Your Honor, I guess this is an appropriate time to discuss what is particularly troubling about the delay, and that is that apparently these shipments are coming in.

THE COURT: Just as they have for 25 years without incident.

MR. ZEDROSSER: Well, but we are afraid there might be an incident, your Honor, and if there were, as there have been aircraft incidents of other kinds lately that don't occur very often, we have a big problem.

I am puzzled by the puzzlement expressed by Mr. Richter in his letter concerning the very large 45 kilogram uranium shipment. He doesn't know why we are

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FOLEY SQUARE, NEW YORK, N.Y. - 791-1020

concerned about it. Maybe that is because they never bothered to answer the complaint. The complaint in Paragraph 13 makes it clear we are talking about the uranium just as much as we are talking about plutonium. The complaint makes it clear at Paragraphs 35 to 40 that we are concerned about the diversion and terrorism just as we are concerned about an aircraft accident. The Mason-Leamer affidavit, Paragraph 42, and Exhibit C to that affidavit make it clear that the kind of material involved in this large shipment is an attractive target for terrorists.

I am extremely concerned not only about the fact that we weren't informed, but much more importantly, about the fact that these shipments are continuing. I noticed that in the letter to the Court Mr. Richter is now trying to limit the U.S. Attorney's prior commitment to the Court in one respect, as to ERDA shipments he now seeks to limit his notice giving to non-military shipments. By this we mean shipments by ERDA as a manufacturer, supplier, fabricator, or whatever.

Inasmuch as the federal government's position on this is that these comprise a large part of ERDA's shipments, and indeed, a significant part of all shipments, we certainly think these should be included as they were before within the notice-giving commitment. These are important.

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE NEW YORK, N.Y. - 791-1020

Finally, Mr. Richter says that, you know, "We really expect that you keep this information confidential." I think that the way we have handled information in this case up until now with the sealing of affidavits and what not indicates that we are operating in good faith and in the public interest. However, we are certainly not going to bind ourselves to not discuss this with other appropriate public agencies or authorities in line with our own responsibility in representing the state. So maybe this kind of thing is done on the theory the best defense is a good offense, but for whatever reason Mr. Richter might have said it, the simple fact is they have failed to live up to the commitment made to the Court, and again, more importantly, this very dangerous material which we have been complaining about since May is still coming in the doors.

THE COURT: I don't know what I am supposed to do in response to that statement except maybe hurry up and decide it, but I am not going to decide it now because you say it's urgent, because you told me that before. I am going to consider the papers, and I am going to decide it, but I don't want to decide it without thorough consideration. It's an important matter to the defendants as well as to the plaintiff .

MR. ZEDROSSER: I would urge the Court that Mr. Richter be held to the original commitment, which is to inform the Court about the shipment of significant quantities of special nuclear materials through New York airports without the limitation that he seeks to insert in his most recent letter. I think it's a significant deletion.

MR. RICHTER: Your Honor, I take it Mr. Zedrosser is referring to the reference to non-military shipments. I do not know of any military shipments going through Kennedy Airport. The reason that non-military was included is that there may be some military bases in New York State where it's conceivable that shipments might go through. I do not know whether that is true or not, but that was included to make it clear that we are not committing ourselves to cover such instances.

THE COURT: Whose jurisdiction would those be under?

MR. RICHTER: Well, sometimes ERDA, I am informed, uses military aircraft to transport material, for example --

THE COURT: Why shouldn't you give notice of those shipments?

MR. RICHTER: Oftentimes these shipments are classified by --

THE COURT: I would assume from the way we are treating even the civilian shipments that they are all classified.

MR. RICHTER: No, oftentimes -- well, for example, as far as civilian shipments, not necessarily ERDA shipments but, for example, NRC licensee shipments, the licensee, when he applies for his license, notice of that is published in the Federal Register. There is no additional notice published as to the method of shipment. Obviously, a military shipment is of greater significance --

THE COURT: You mean before the shipment takes place, there is a notice in the Federal Register that a shipment is going to take place?

MR. RICHTER: No, not that the shipment is going to take place, but that the license has been granted.

THE COURT: Not stating where or when the shipment will take place?

MR. RICHTER: That's correct.

MR. ZEDROSSER: Or even how, I believe. Is that correct?

MR. RICHTER: That is also correct, but I find Mr. Zedrosser's statements to be high objectionable, your Honor. First, this is a voluntary commitment that we made. We are not under any Court order. What Mr. Zedrosser is

apparently trying to do is to rush this Court into making a judgment. One thing which Mr. Zedrosser has failed to state today, has failed to state in his letter to the Court, is that this entire matter is before Congress. It now appears that Congress might not even get to it until it takes its August recess, and it won't return until September. If Congress is not racing to render a determination, there is no reason why the state should now rush and try to push this Court into making a determination.

Secondly, because there is no outstanding court order, we agreed on a voluntary basis to notify the state. If the state is now not prepared to keep this information confidential, then we would ask that we be released from our commitment.

Thirdly, we are not even clear as to why the state wants this information. What has happened with the two shipments --

THE COURT: I am not too clear either, except I guess if there was going to be a monster shipment, they would come rushing in for a special TRO with respect to it.

MR. RICHTER: But as to that, as far as enriched uranium goes, your Honor, if there were going to be a monster shipment, and what they are concerned about is that it might

be highjacked, then what the state could do is provide additional police protection. There is no reason to bother this Court in such a situation, and as I asked for in the letter that I wrote to Mr. Shea today, that we receive a commitment from the Attorney General's office that they will do everything in their power to stop the harassment of these shipments, which has occurred.

Since our conference on May 7th, there have been two shipments that I know of. One was a shipment of less than one ounce of plutonium, which I notifed the Court of by letter and I was told that the fire marshal at Kennedy attempted to stop that shipment without any lawful basis for doing so.

The second shipment that I know of is the one that is addressed to in Mr. Shea's letter, which was the shipment of last week of high enriched uranium, which the state, or at least the city -- I withdraw that -- both the city and the state knew of that shipment before it even entered the city. It was met by Dr. Leonard Solon of the Department of Health at the George Washington Bridge. Dr. Solon attempted to stop that shipment. I was also informed it was met by the Police Department, who were there to give it protection.

The airlines notified the Port Authority, an

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FOLEY SQUARE, NEW YORK, N.Y. - 791-1020

official of the Port Authority at JFK Airport that the shipment was going to be flown out. They were notified on July 8th. I believe the shipment went out the 9th or the 10th. The truck, by the way, was stopped from some time before midnight on July 8th until about 5 in the morning on the following day.

THE COURT: Stopped where?

MR.RICHTER: At the George Washington Bridge.

THE COURT: They talk about the increased likelihood of highjacking.

MR. ZEDROSSER Yes, and that's quite false, your Honor. If I may speak to that for a moment, your Honor, I think I can answer the Court's question.

First of all, as to the voluntariness of Mr. Richter, the U.S. Attorney's representation, if I recall correctly on page 23 of the transcript of the first conference in this case, the Court indicated that it was denying the TRO in part because it was not satisfied that there was a threatened air shipment. That was because of the diverted shipment. Then the Court asked Mr. Richter to give notice, and he said, "Certainly."

Whether that is voluntary or not, it seems to me that it was done for a purpose in this case from which the defendants have benefitted, and to now say that it was

some kind of beneficent act on their part to give or take away as they choose I think is to put the wrong turn of phrase.

THE COURT: Let me say if it is correct that that information was used for the purpose of stopping shipments and holding them for hours in the middle of the night, that is not a purpose for which the Court made the suggestion.

MR. ZEDROSSER: That is an outrageous false representation by Mr. Richter. The state did not have that information prior to the entry. The city apparently did. Dr. Solon is an employee of a city agency. He went there. He didn't tell us he was going before he went. We found out afterwards. It's not true that that was held up for five hours at the bridge. It went on after very little time. It is not true that the Port Authority JFK people were given proper notice. They were not given the proper 24 hours notice.

We do not represent Dr. Solon. We do not represent the City Health Department. That the state or any client of ours has harassed any of the shipments as far as --

THE COURT: Did the state furnish information of the ships to the city?

MR. ZEDROSSER: We did not furnish information of

that shipment to the city. We learned about it afterwards. The city obviously learned because they had Dr. Solon there.

MR. RICHTER: If I may interrupt you for one second, Mr. Zedrosser, I was in no way saying that you were caused, that your office caused the harassment which occurred of these shipments. What I am asking from you, and what I am asking in this letter is -- well, I am asking two things today: One, what is the purpose of notifying you?

And secondly, if we are going to notify you, then we want from your office a commitment that you will do everythingin your power to see that the persons you represent, which includes the individuals who live in the City of New York, donot interfere with the lawful transportation in interstate commerce of special nuclear materials.

If you expect us to make a voluntary commitment to you to supply you with the information --

MR. ZEDROSSER: You made it to the Court, sir.

MR. RICHTER: -- I see no reason why you cannot similarly commit yourself that you will do everything in your power to support the law and to permit lawful transportation of these materials.

MR. ZEDROSSER: We do not concede a lack of

jurisdiction on the part of the state to act to protect its citizens, period.

THE COURT: Why do you need the federal court then?

MR. ZEDROSSER: Pardon me?

THE COURT: Why do you need the federal court?

MR. ZEDROSSER: We need it because they violated a federal law creating an independent remedy, the National Environmental Policy Act. They persist in trying to shift the burden from their own clear violation of the federal law to almost anybody else they can find. The simple fact is that no state officer has interfered with --

THE COURT: Mr. Richter, you are free from any undertaking to furnish information about the shipments unless there is a commitment that that information will not be used by the state for the purpose of interfering with the shipments. If the state is going to use self-help, it can count on less cooperation from me insofar as I have discretion.

MR. ZEDROSSER: The Court is willing to do that even though there has been no allegation that the state has done anything here?

THE COURT: If you are willing to say, as Mr. Richter has suggested, that the state will not use the

information that he is furnishing for the purpose interfering with the shipments, then he will continue to furnish the information. If you won't do that, then I don't think he ought to be required to continue furnishing the information.

MR. ZEDROSSER: And that leaves, apparently, as a completely irrelevant fact that the TRO here was denied in part because the Court felt and said on the record that it was not satisfied that shipments were coming in. Now we are to remain in the dark during the pendency of the determination of the preliminary injunction motion while the defendants ship or allow the shipment of these articles in violation of law.

Now again, Ican only say I suppose, you know, the best ~~offense~~ defense is a good offense, but it seems to me this is turning everything on its head. This is forgetting about what this suit is about, not giving us the very crumb, almost, of notification,because they claim we might do something which they can never prove we have done ~~or~~ and haven't done.

THE COURT: You can get the crumb or the loaf. You can get the notification if you will simply make the undertaking that the information being furnished to you will not be used for the purpose of impeding the shipments.

That seems to me a reasonable request.

MR. ZEDROSSER: Yes, sir. Your Honor, I think that as to just on the facts, that as to one other thing, that is the prior shipment of plutonium, he talks about this fire marshal, which I think is incorrect, but anyway, a Port Authority employee. Again, the Port Authority, as the Court is well aware, is a corporate body created by Interstate Compact. We dont' represent them either. What did happen though is very instructive, because it shows the shoddy way in which the shipments are conducted by the defendants and allowed to be conducted. What happened was that the Port Authority didn't get the required notice, and very properly at an early stage, before it ever got here, said, "We are not going to take it on that notice."

When it got here, interestingly enough, it was not marked according to the regulations. Alitalia refused to take it. Accordingly, because of the shoddy way in which this was handled, it had to sit outside of the airport in a private warehouse for about a week before it could get the next flight out. This kind of things shows exactly what we are worried about.

It seems to me, if you want to look at those facts, far from saying that we did anything to harass anybody,

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FOLEY SQUARE NEW YORK, N.Y.

they just show why this kind of thing is crazy for the transport of plutonium and other special nuclear materials.

MR. RICHTER: Your Honor, I could respond to that, but I think the simpler thing is for me to again ask Mr. Zedrosser if he is willing to make the commitment as I asked.

MR. ZEDROSSER: No. I think it's completely unnecessary and uncalled for.

MR. RICHTER: Then I ask this Court to relieve us of any commitment.

THE COURT: I have indicated I would so relieve you.

MR. RICHTER: Thank you, your Honor.

THE COURT: I don't think they ought to be required to furnish information that is going to be used against them in a self-help fashion.

MR. ZEDROSSER: Nor have they indication that it will be, and in fact it has not.

THE COURT: All you have to do is say that it won't be, and they will continue to furnish the information.

MR. ZEDROSSER: I refuse to bind the state in that way. I think that is uncalled for.

THE COURT: All right.

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. 10007

MR. ZEDROSSER: And as to what we want this information for, I think the --

THE COURT: If you can furnish a good reason for having the information, I will reconsider.

MR. ZEDROSSER: I think the Court was quite right that obviously if we learned of a large shipment in advance, as opposed to after the fact, at this time, we could go to the Court and see if we could get some kind of remedy, absolutely, and that's whatthis suit is all about.

THE COURT: All you have to do is to say you are not going to use self-help, you are going to come to the Court and try to get your remedy instead of trying to barricade the bridges.

MR. ZEDROSSER: We have not done that, and I don't know that we are going to do that. All I am saying is --

THE COURT: All you have to do is say that you won't.

MR. ZEDROSSER: I am not here for the state to bind the state in this way.

THE COURT: All right.

MR. ZEDROSSER: This is a case where the illegal activity is done by the federal government. I think this is a topsy-turvy land.

THE COURT: All right.

It won't be the first time I was wrong.

What further can we accomplish today?

MR. ZEDROSSER: To end with a whimper instead of a bang, this is the affidavit of Dr. Gofman which Mr. Shea referred to last time, which makes certain arithmetic corrections. A copy has been served on the U.S. Attorney's office.

THE COURT: Allright, anything else?

MR. RICHTER: Not as far as the federal government is concerned, your Honor.

Thank you, your Honor.

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rgrf

UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF NEW YORK

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THE STATE OF NEW YORK, :

Plaintiff, :

-against- : 75 Civ 2121

THE NUCLEAR REGULATORY COMMISSION, et al., :

Defendants. :

----------x

BEFORE:

HON. WILLIAM C. CONNER,

District Judge

New York, New York
July 31, 1975 - 5:25 p.m.

APPEARANCES:

LOUIS J. LEFKOWITZ, ESQ.,
Attorney General of the State of New York
BY JOSEPH J. ZEDROSSER, ESQ.,
JOHN F. SHEA, III, ESQ.,
Assistant Attorneys General.

PAUL J. CURRAN, ESQ.,
United States Attorney for the
Southern District of New York
BY: NATHANIEL L. GERBER, ESQ.,
Assistant United States Attorney.

(In chambers.)

MR. GERBER: Your Honor, I am sorry if I kept the Court waiting.

THE COURT: Don't apologize. This is my last day here before a two week vacation and I would have been gone if I hadn't gotten the call.

MR. ZEDROSSER: Your Honor, at this time I would like to hand up two affidavits, very brief, in support of a renewed motion for a temporary restraining order. A copy of this has been just a moment ago handed to Mr. Gerber. We would ask that these affidavits be sealed in accordance with prior practice in this case.

THE COURT: It appears, Mr. Zedrosser, that there is going to be a shipment and that it does entail at least some danger of hijacking by terrorists who could use the material being shipped to fashion a fission bomb if they had the necessary knowhow, but there is nothing here that would satisfy me that a shipment by air poses any greater threat of hijacking than shipment by any other means.

For example, by truck.

Now, if you keep it out of New York State it is presumably going to come in by air somewher e else so that there is going to be a danger of some magnitude

even if I grant the order and I am not satisfied that the danger will be any less if I grant the order.

MR. ZEDROSSER: Your Honor, I think the issue here is not merely one of whether the transport is by air or by surface transport, but by the type of air transport which in reality is involved. This would be an NRC licensed shipment with a commercial shipper, Transnuclear, Inc.

Based on the way this has been handled in the past it would go by commercial airlines through JFK. In the affidavit of Messrs Mason and Leamer -- and while I can't cue it into all the paragraphs I would say starting with paragraph 45 and following it is quite clear that there are particular grievous security problems involved with the commercial air transport of materials through an airport such as JFK and as it happens the comments of Messrs. Leamer and Mason specifically relate to the security problems at JFK.

THE COURT: Are the security problems any better at a pier in Brooklyn or in Bayonne than they would be at JFK?

MR. ZEDROSSER: Well --

THE COURT: I doubt it.

MR. ZEDROSSER: Mason and Leamer seem to feel

certainly that the security where there is a shipment carried on in the military manner would be considerably better than that involved in a commercial transport which we are here talking about and that is in their affidavit. I point to pages 20 and 21 of the Mason and Leamer affidavit. But the fact of the matter is this is being shipped the same way we ship a lot of things that we are not concerned with the security on and that really ~~don't~~ doesn't seem to make sense since as the Court has pointed out there clearly is some danger here.

THE COURT: I don't doubt that there is danger, but I have got to consider whether the alternatives that might be employed if I sign the order are less dangerous and that is what I am not satisfied about.

MR. ZEDROSSER: I would direct the Court's attention, then, to what Messrs. Leamer and Mason have said and it seems clear from their affidavit that in their view there is a safer way to do it and that would be military transport rather than the commercial kind of transport that we are talking about here.

THE COURT: When is the shipment due at Kennedy?

MR. ZEDROSSER: Well, the best information we have on that is what we put in the affidavit, and as we have indicated all that we have learned is that originally

the shipment was to have been licensed this week and brought in in early August. We have also learned that apparently that the shipper has been told that the license wouldn't be forthcoming this week. This leaves us hanging. We don't know how much of a delay there would be. That is why we came in today. We knew the Court would be gone and we couldn't take the chance that it would be delayed until later. That is frankly the best information we have as far as dates.

THE COURT: Is there any particular time urgency about this shipment?

MR. GERBER: Your Honor, I was only notified of this TRO about a half an hour ago by your law clerk. In the few minutes that were available I called counsel at ERDA and NRC and Mr. Cunningham who is counsel at NRC advised me that at that moment he had no knowledge of any immediate shipment.

Of course, neither he nor I had an opportunity to verify this so I can really make no definitive representation to the Court, but frankly my reading of that paragraph in the affidavit, paragraph 2, would indicate that frankly it is since the NRC license would not be forthcoming this week, that the shipment is certainly not going to be immediate and not within the next few days and that is

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. — 791-1020

about all I can say at this time.

THE COURT: What I am really wondering about is is this a military surface vessel coming this way within the near future which could be used as an alterrative means of transportation without serious prejudice to the NRC or to the shipper in this case.

MR. GERBERG: I can't answer that at this time.

THE COURT: That is the problem, really. I have got to think about the consequences of entering the order. I couldn't sign the order without giving the defendants at least an opportunity to demonstrate that there are no viable alternatives to the particular method of transport chosen.

If there was, as Mr. Zedrosser suggests, a surface vessel coming this way which could be used as an alternative means of transport with a loss of no more than four or five days in time and unless that loss of time was critical I would obviously be inclined to sign the order, but I don't know this. I can imagine a situation where this would result in a delay of 30 days or so and I can further imagine that that time might even be critical.

MR. ZEDROSSER: Your Honor, I think it is clear that on that particular point, as the Court correctly

said, the defendants here must have the burden of going forward. I am not aware of ship movements in the North Atlantic.

THE COURT: I am not either.

MR. ZEDROSSER: And there is no way that I can become so.

THE COURT: I can't sign the order without knowing what the consequences of the order are. It is I think beyond dispute that some hazards are involved in every shipment of these materials, but I am not going to sign an order without knowing where it leads us.

Since I haven't had any time off and was planning to take only two weeks off I am not very much disposed to give it up and to stay around so that I can have a hearing on this. There will be a judge sitting on emergency matters in my absence, the Part I judge, who next week will be Judge Stewart. I have no objection to your applying to Judge Stewart for this relief, and of course I assume the Government will tell him what I have said, but I am not disposed to sign the order unless I know what alternative means of shipment are available and I am satisfied that the alternative means of shipment posed a significantly lesser hazard.

MR. ZEDROSSER: Your Honor, in view of the

fact that we have brought this matter to the Court's attention I think perhaps there would be a mechanism whereby our application could remain open and as your Honor pointed out Judge Stewart might be able to hear it rather than make us reapply in some way.

THE COURT: No, I am not denying it on the merits, I am denying it simply because I am not going to enter the order without more information than I now have. I am deferring action on it without prejudice to having it set for a hearing before Judge Stewart after the government shall have had an opportunity to marshal the facts it needs in order to be able to oppose the order.

MR. ZEDROSSER: Is the Court going to be gone tomorrow?

THE COURT: Yes. That wouldn't give the government time enough to get the information together in any event.

MR. ZEDROSSER: What I would propose is at least putting the papers before Judge Stewart tomorrow thereby giving him the weekend if he so desires.

THE COURT: He is not on duty tomorrow. You see, Judge Weinfeld is on duty tomorrow for extreme emergency matters only, but just for the one day. You see, Judge Stewart's term starts on Monday. Judge Weinfeld is merely sitting in for me tomorrow, but he will not be sitting on

Monday on these matters, so he is not going to study anything over the weekend and then tell you on Monday about it and I am not going to give you permission to bother him tomorrow about it because he is sitting in for me for emergency matters and I can tell you that that is not going to give the government sufficient time to get the information it needs to oppose.

So I would think that what you ought to do is to bring it on before Judge Stewart next week. See him on Monday. In the meantime the government should do the best job it can of getting the information necessary to oppose the papers, and if it hasn't had sufficient time by Monday tell him it needs more time and how much it needs and let him set a date.

MR. GERBERG: Your Honor, I apologize for appearing for the government in such ignorance, but frankly I notice that in paragraph 2 of the affidavit, Mr. Shea's affidavit, he indicates that he learned yesterday from Transnuclear, Inc. that the licenses originally were expected to be approved by NRC this week. Frankly, if the government had learned of it yesterday we might have been able to gather the information in time for this conference today, but not having heard about it at all from the state and only from your law clerk we have had no

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. 791-1020

opportunity whatsoever.

THE COURT: It did take some time to prepare the Shea affidavit. I don't know whether the graph attached to it was prepared for this specific purpose, but at least --

MR. ZEDROSSER: It was, your Honor.

THE COURT: At least the State of New York could have notified you that they were going to make an application and what the substance of the application was so you could have been working simultaneously with them and by failing to do so obviously they deprived you of sufficient time to get ready for this hearing.

MR. ZEDROSSER: Your Honor, we will go before Judge Stewart on Monday in accord with the Court's suggestion.

THE COURT: He will be tied up all Monday morning on the criminal docket, so there is no sense in trying to see him before Monday afternoon.

MR. ZEDROSSER: Will that be sealed, your Honor?

THE COURT: Yes, by all means.

MR. GERBER: Thank you, your Honor.

MR. ZEDROSSER: Thank you very much.

(Adjourned.)

UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF NEW YORK

STATE OF NEW YORK,

Plaintiff,

-against-

75 Civ. 2121

THE NUCLEAR REGULATORY COMMISSION, et al.,

Defendants.

Before:

HON. WILLIAM C. CONNER,

District Judge

New York, August 20, 1975
Room 1506 - 11:40 a.m.

APPEARANCES:

LOUIS J. LEFKOWITZ, Esq.,
Attorney General of the State of New York,
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Assistant Attorney General

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SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. — 791-1020

MR. ZEDROSSER: Your Honor, I contacted chambers yesterday shortly after, I understand, Mr. Richter did because the subject of our last discussion here some two and a half weeks ago is now once more in the forefront, namely, the shipments of Uranium Hexaflouride that were the subject of the Shea and Skinner affidavits which were submitted the last time.

THE COURT: There is a contemplated shipment as indicated by the affidavit of Macklin.

MR. RICHTER: That's correct, our Honor, the affidavit has not been signed. Mr. Macklin has been told about it, it's been read to him. As a matter of fact, the changes in ink I supplied after he told me to do so. He was supposed to come by at 2 o'clock to sign the affidavit. I will have him sign the affidavit and I will file the original with the Court.

I would also ask that the affidavit be sealed, your Honor.

THE COURT: All right, it will be sealed and I will treat it for present purposes as though it had been filed.

I think the recent actions of the Congress are extremely relevant to what we are doing here. Apparently, insofar as shipments of plutonium by persons licensed by the

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. - 791-1020

Nuclear Regulatory Commission are concerned, the case is not now moot. If the bill which was recently passed by the Senate also passed by the House and signed into law as appears a very substantial likelihood, the shipments of plutonium by ERDA will also be enjoined except for certain very limited exceptions, and I would think that insofar as shipments of plutonium are concerned, there would be very little left to decide. There will remain, of course, shipments of other special nuclear materials including the Uranium Hexaflouride we are talking about now. However, it seems to me that Congress has recognized a distinction between plutonium on the one hand and the other special nuclear materials on the other, and the affidavits on file give me the impression that there is a substantial logical basis for that distinction if that plutonium is shipped in the form of a very fine powder which is extremely fugacious and once released is virtually impossible to confine whereas the other special nuclear materials are heavier and are of such nature that when they are released they tend to stay in one spot from which they can be recaptured with appropriate precautions to protect the work involved and also to decontaminate the surrounding area. Am I mistaken about that?

MR. RICHTER: I respectfully submit that that

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. - 791-1020

specific portion of what you just said, your Honor, is incorrect. Plutonium is not impossible to confine if released as stated in the affidavits we have submitted. It is a very sticky substance and would stay confined.

THE COURT: I am not concerned at the moment with plutonium really. The part of the statement as to which I would like your agreement or disagreement is the part in which I stated that the other special nuclear materials are less fugacious than plutonium and their release does not pose the same problems of recapture that plutonium does.

MR. RICHTER: You are correct, your Honor, that as to other ~~special~~ special nuclear materials which, what we are talking about, is uranium, ~~U-2, 3, 4, 5~~ U-235 high enriched, it does not present any safety problems as has been agreed by the parties because it is of a lower radioactive type than plutonium and it would be difficult, if not impossible, to inhale a sufficient quantity to do any noticeable damage to a person if the material were released in a transportation accident. I would just point out that I don't think there is any dispute about this between the parties. In the affidavits submitted by the State by Dr. Gofman, I believe it is in Paragraph 4 of that affidavit, He says that there is no safety hazard from the air transportation of uranium no matter what degree of enrich-

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. - 791-1020

ment.

THE COURT: And that obviously then would apply to the Uranium Hexaflouride we are talking about in this shipment.

MR.RICHTER: That's correct.

MR. ZEDROSSER: Your Honor, if I may be heard also, I think that maybe using the term "safety" is an inappropriate way to designate this. The most that can be said is that there isn't the air accident problem resulting from dispersion that we have with plutonium. As we have said from the inception of this case, there is a significant danger to the public health and safety resulting from the diversion and possible use of these materials or threatened use of the materials by a terrorist. Obviously, if a terrorist obtains the material, builds a bomb and explodes it, that is a threat to the public health and safety, but I think, labels aside, now what we are talking about, I don't know, your Honor, whether it is in the affidavits that one or the other substances is heavier, precisely, but if the point is, is it an accident problem or a terrorist problem, it is a terrorist problem. Now, as to the earlier things --

THE COURT: Insofar as the terrorist problem is concerned, my own very strong feeling is that hijacking is more of a hazard with truck shipments or railroad

shipments than it is with airplane shipments. If you are shipping by air, you need only protect the ground terminals and the air crews, you do not need to protect every inch of the route from the origin to the destination as you do in the case of a surface shipment. That's born out by the affidavit of Mr. Macklin and by common sense.

MR. ZEDROSSER: Your Honor, I think what's at issue here is the commercial air shipment of the materials, and I think to view this in the abstract is a mistake. We have, for a long time, and this is in the submissions, formal submissions of the affidavits of Messrs. Mason and Leamer have pointed out the particular hazard in shipping these things commercially, and the last time we were before your Honor, the Court specifically asked the U.S. Attorney's office representative, Mr. Gerber, at that time as to whether or not it might be possible to ship this material by military transport. I think to say that it is simply a problem of air versus surface as far as uranium, isn't the whole story. Let's talk about the kind of air shipment -- we are talking about the real world where it goes in and out of JFK airport, not the most secure facility in the world. Why can't this, at the very least, be shipped, not to Chicago but to several Air Force bases much closer to Portsmouth, there is the Rickenbacker Air Force base in Columbus,

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. 10007

there is the Wright-Patterson near Dayton and a couple of others -- if we are going to talk about common sense, your Honor, I respectfully submit that common sense would lead us toward a much more secure form of transport here.

THE COURT: I don't know whether that's practicable. What do you have to say about that, Mr. Richter?

MR. RICHTER: First of all, I think the reasoning leaves me bewildered. What the state is asking for, then is if high enriched uranium cannot be shipped by military aircraft, then it wants its shipment by air to be enjoined, instead it then goes by commercial ground shipment and this just makes no sense. If what the state is saying is that all shipments by whatever means of high enriched uranium should be by military transport, that's not the subject matter of this lawsuit.

THE COURT: I know that, we are talking about this one shipment which is the subject of our present discussion today. Would it be possible to compromise by arranging for the transportation of that shipment by military aircraft?

MR. RICHTER: No, it would not, your Honor, the United States Government is against the use of military transportation. These materials have been transported commercially for 25 years. To attempt, now, to change this to a military system would require an act of

Congress. There are also two practical things I would like to point out, your Honor. I think what the state is really talking about is some sort of military guard over these materials, not merely a matter of flying it into the military airport but also they'd be under military guard. We have talked -- I should say Mr. Gerber has talked to officials at the Department of Defense and they say that that could not be done for two reasons. First, the military cannot supply such guards. It is ~~in~~ the position of the Department of Defense that that would be in violation of 18 USC 1385 and secondly, use of military equipment to transport these commercial items, the Department of Defense feels would be in violation of appropriation ~~of~~ bills. They pointed out that funds appropriated ~~by~~ For the Department of Defense are furnished for specific defense purposes and commercial use would contradict specifically appropriation purposes, and this would be in violation of 31 USC 628, your Honor.

MR. ZEDROSSER: Your Honor, I find it very interesting that when it serves the defendants' purposes they wrap the mantle of international relations ~~in~~ and foreign policies about themselves, about all the shipments, commercial or otherwise. When it doesn't serve their purposes they say, "Oh, these are private shipments.

We certainly can't be sensible and use ~~the~~ military air."

I find that a little bit more wooden than I am prepared to expect the United States Government to be. It is interesting that the other point that your Honor asked about the last time we were before you was, how urgent is this. If you read this "almost" affidavit of Mr. Macklin you find out that ~~words~~ it would ultimately ~~join~~ go into a research reactor and not even in the United States but a research reactor abroad. No one is going to be in the cold and in the dark as a result of any delay if there were a delay. I think we ought to put the need for speed in that context.

THE COURT: We come down to a choice between the contemplated shipment by a commercial freight aircraft or a shipment by surface transportation, and insofar as the risk of hijacking is concerned, I am still convinced as Mr. Macklin asserts that more risk is involved in surface transportation than in shipments, even by commercial aircraft insofar as the danger of crash is concerned, apparently there is no real hazard to anyone's life or health, even if a crash should occur, and under the circumstances, I don't believe there is sufficient basis for me to grant the extraordinary relief of enjoining the contemplated shipment. As I indicated befcre, this is a matter of weighing evils, shipment by air is an evil but all of the alternatives also

involve evils, and I am not convinced that they are substantially better than the contemplated method, and I am not going to grant that injunction against this particular shipment.

MR. ZEDROSSER: Your Honor, at the outset of your comments you made some general statements about the effects of the recently enacted NRC amendment and the proposed ERDA amendment. I am wondering if your Honor has had a chance to look at our letter which we handed to your clerk just shortly before this.

THE COURT: I read it very briefly and I realize that there are some things that will not be disposed of by the present statute and the pending legislation. The case will not entirely become moot, and I will not be spared the duty of ruling on your motion for preliminary injunction which I hope we can do by about the end of this month.

MR. ZEDROSSER: I assume that your Honor is referring to the exception to the various proposals.

THE COURT: Also to the fact that both statutes cover only plutonium.

MR. ZEDROSSER: As I think we made clear in your letter, it is our view that these amendments do not moot any of our case. Our case is founded upon a preexisting violation

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. — 791-1020

of an independent federal obligation, that is the one under NEPA.

THE COURT: The relief you seek is an injunction against the shipments and if the shipments are prevented by a statute, then you don't need an injunction. You need an injunction only to the extent that the shipments are not prevented by statute.

MR. ZEDROSSER: The problem is the terminating event in the statute is a certification to the Congressional Joint Committee. The terminating event for a permanent injunction under NEPA would be the filing of an impact statement, an adequate impact statement under NEPA whereas the terminating event for the preliminary injunction would of course be the final conclusion of the lawsuit. Those are three different things in substance and they may occur at very different times. I have no idea if and when there is going to be a certification to the joint committee. I do not think that the case is mooted at all, and it seems to me that where the plaintiff here has for three and a half months been seeking relief, filed substantial affidavits, appeared a number of times, the relief appropriate and tailored to this case ought not to be withheld because the Congress has gone off and done something else.

THE COURT: I misunderstood the relief you are

seeking in this lawsuit. I thought you wanted a preliminary injunction. But that any preliminary injunction you would get would be terminated if an adequate environmental impact statement is filed which is the same terminating event, that would be applicable in the case of the statute, is it not?

MR. ZEDROSSER: It is not. The impact statement and the legal requirements thereof are not necessarily the same at all as the certification to the joint committee.

MR. RICHTER: What would have to be certified to the joint committee is that the container used to transport plutonium by air could survive a high flying air crash, and the joint committee would then have to decide ~~on the phone~~ I am told? whether this certification, whether they would accept the certification or not. It would seem to me that if Congress determines that there is a container which can survive a high flying air crash, then there is no basis for the preliminary injunction.

THE COURT: I can tell you there is no container on earth that will survive impact in a perpendicular collision, that is a plane flying vertically and hitting the earth. I remember very vividly when I was in the Navy during World War II, I was having lunch in the officer's club one day and I heard this terrible crash, and a plane had

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. – 791-1020

gone in vertically, no more than a couple of a tenth of a mile away from where I was sitting. I walked over to the spot. There was a hole about two feet across. The entire plane had gone into that hole and disappeared. You couldn't see the bottom of the hole and there were just a few whisps of smoke coming out of it, but the entire craft had disappeared into a hole 2 feet across and of unknown depth. The metal had been vaporized. There is no container on earth that could sustain or could survive such a crash. I don't believe that there is going to be any possibility of a truthful certification that a container could survive such an impact.

MR. ZEDROSSER: In any event, I hope we have made clear both in the letter and orally that we do consider the two events, the certification, if and when it ever would occur, and the filing of impact statements are really quite different both in substance, as perhaps the Court has emphasized by the anecdote and also in whatever time it might occur, so that there is a difference between what the Congress has done and what is involved in this NEPA.

THE COURT: This will be taken under consideration in our ruling on the motion for preliminary injunction, but I will abide by my decision that I will not grant a specific injunction against this contemplated shipment.

SOUTHERN DISTRICT COURT REPORTERS, U.S. COURTHOUSE
FOLEY SQUARE, NEW YORK, N.Y. - 791-1020

MR. RICHTER: Thank you, your Honor.

MR. ZEDROSSER: Thank you.

(Time noted: 12 noon.)

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75-1672

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK,

Plaintiff,

-against-

[illegible] AR REGULATORY COMMISSION,

Defendants.

ANSWER

75 Civ. 2121 (WCC)

Defendants, Nuclear Regulatory Commission ("NRC") [illegible] William Anders as Chairman, Energy Research and Development [illegible] Administration ("ERDA") and Dr. Robert C. Seamans as [illegible]ministrator, Department of Transportation and William T. [illegible]man as Secretary of Transportation, Department of State and Henry A. Kissinger as Secretary, Federal Aviation Administration and James E. Dow as Acting Administrator, by their attorney, Paul J. Curran, United States Attorney for the Southern District of New York answer the complaint herein as follows:

1. Admit the allegati[illegible]s contained in paragraphs 1, 3, 4, 20, 24, 25, 28 and 29.

2. Deny the allegations contained in paragraph 2, except admit that this Court has jurisdiction pursuant to 28 U.S.C. § 1331 and that venue is based upon 28 U.S.C. § 1391.

3. As to paragraph 5, admit that plaintiff is a body politic and a sovereign entity that resides in and has offices in the Southern District of New York and brings this action on behalf of itself, but deny knowledge or information sufficient to form a belief as to the other allegations contained in the first sentence and deny the allegations contained in the second sentence.

889

EFR:iw

4. As to paragraph 6, admit the allegations contained in the first sentence and deny the allegations contained in the second sentence, except admit that the duties of the Chairman of the Nuclear Regulatory Commission are set forth in 42 U.S.C. § 5841.

5. As to paragraph 7, admit the first sentence; deny the second and third sentences, except admit that the duties of the Chairman and the functions of the Energy Research and Development Administration are set forth in 42 U.S.C. §§ 5813 and 5801; admit the allegations contained in the fourth sentence; and admit the allegations contained in the fifth sentence, except deny that much of the alleged transportation is done by air.

6. As to paragraph 8, admit that defendant William T. Coleman is the Secretary of Transportation and the head of defendant Department of Transportation, an executive department of the Federal government, and that his duties are set forth in 49 U.S.C. § § 1652 and 1653, but deny the other allegations contained in the first sentence; and admit the allegations contained in the second sentence.

7. As to paragraph 9 of the complaint, admit the allegations contained in the first and second sentences; deny the allegations contained in the third and fourth sentences, except admit that periodically the United States enters into international agreements of cooperation pursuant to Section 123 of the Atomic Energy Act which provide for the exchange of nuclear materials, including special nuclear materials, and technology for peaceful purposes including production of electrical power and research.

8. As to paragraphs10, 12, 19 and 21, neither admit nor deny since these paragraphs are applicable to defendants Civil Aeronautics Board and United States Customs Service.

890

CFR:iw

9. Deny the allegations contained in paragraph 11, except state and admit that James E. Dow is the present Acting Administrator of the Federal Aviation Agency and that the obligations and duties of the Administrator in regulating the transportation of hazardous materials are set forth in 49 U.S.C., §§ 1348, 1357 and 1421 (a)(6).

10. As to paragraph 13, admit the allegations contained in the first and second sentences, except deny that the NRC issues licenses for domestic transport of special nuclear materials except as provided in 10 C.F.R. 71.5; and deny knowledge or information sufficient to form a belief as to the truth of the allegations contained in the third sentence.

11. As to paragraph 14, admit the allegations contained in the first and second sentences, and deny the allegations contained in the third sentence except insofar as NRC licenses domestic shipments of special nuclear materials pursuant to 10 C.F.R. 71.5.

12. Deny the allegations contained in paragraph 15, except state and admit that licenses issued by the NRC for the import or export of special nuclear materials cover the quantity of such materials to be exported or imported and it is left to the licensee to determine the number of shipments that will be made to transport the quantity of material licensed into or out of the United States.

13. As to paragraph 16, deny the allegations contained in the first sentence, except admit that the United States enters into international agreements of cooperation pursuant to which nuclear materials are transferred between the United States and foreign countries, and admit the allegations contained in the second sentence.

14. Deny the allegations contained in paragraph 17, except admit that ERDA's Office of the Assistant Administrator

891

CFR:iw

for International Affairs participates directly in the drafting of such international agreements and that ERDA's Division of International Security Affairs assures that the exports of special nuclear materials are in accordance with International Agreements of Cooperation.

15. As to paragraph 18, admit the allegations contained in the first and second sentences, and deny the allegations contained in the third sentence.

16. As to paragraph 22, admit the allegations contained in the first sentence and deny the allegations contained in the second sentence, except admit that ERDA is exempt from the licensing requirements of the NRC.

17. Admit the allegations contained in paragraph 23, except deny that 500,000 curies of PuO_2 were imported and state that the actual amount was 365,553 curies.

18. Admit the allegations contained in paragraph 26, except deny that 500,000 curies were imported and state that the actual amount was 427,260 curies.

19. Deny the allegations contained in paragraphs 27, 35, 40, 43, 44 and 45.

20. Admit the allegations contained in paragraph 30, except deny that the NRC licenses domestic shipments of special nuclear materials except as provided in 10 C.F.R. 71.5.

21. Deny the allegations contained in paragraph 31, except admit that defendants have not filed a generic Environmental Impact Statement concerning the air transportation of special nuclear materials and further state that the NRC is in the process of preparing such a statement and announced its intention to do so prior to the commencement of this action.

892

CFR:iw

22. Deny the allegations contained in paragraph 32, except admit that as of the date of this answer there are import licenses outstanding permitting the import of uranium 235 into the United States and export licenses permitting the export of plutonium and uranium 235 from the United States.

23. As to paragraphs 33 and 34, admit that after the complaint was filed air shipments by ERDA and NRC licensees of special nuclear materials, including plutonium, were made involving J.F.K. Airport in New York.

24. Deny the allegations contained in paragraph 36, except admit that plutonium and uranium with a very high enrichment of the isotope 235 are suitable for manufacture into nuclear weapons.

25. Deny the allegations contained in paragraph 37, except admit that such a Special Safeguards study was prepared and state that the conclusions of the study do not necessarily represent the opinion of the NRC.

26. Deny knowledge or information sufficient to form a belief as to the truth of the allegations contained in paragraphs 38 and 39.

27. As to paragraph 41, refer the Court to 42 U.S.C. 4321 et seq. for the full text of the National Environmental Policy Act of 1969.

28. As to paragraph 42, admit that the Council on Environmental Quality was created pursuant to NEPA and that such Council has issued guidelines on the preparation of

impact statements which are contained in 40 C.F.R. § 1500

CFR:iw et seq. to which the Court is referred for the full text of such guidelines.

Dated: New York, New York
August 1, 1975

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894

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YOP

- X

THE STATE OF NEW YORK,

Plaintiff,

- against -

The Nuclear Regulatory Commission, and WILLIAM ANDERS as Chairman; the Energy Research and Development Administration and DR. ROBERT C. SEAMANS as the Administrator; the Department of Transportation, and WILLIAM T. COLEMAN as Secretary of Transportation; the Department of State and HENRY A. KISSINGER as Secretary of State; the Civil Aeronautics Board and ROBERT D. TIMM as the Chairman; the Federal Aviation Administration and ALEXANDER P. BUTTERFIELD as the Chairman; the United States Customs Service and VERNON B. ACREE as Commissioner and FRED R. BOYETT as Regional Commissioner,

Defendants.

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75 Civ. 2121 (WCC)

MEMORANDUM AND ORDER

CONNER, D. J.:

This action under the National Environmental Policy Act (NEPA) charges defendants with having violated 42 U.S.C. § 4321 et seq., its policies and goals by transporting or allowing the transportation by air of plutonium and other special nuclear materials (SNM) [1/] without having issued an environmental impact statement (EIS) as required by Section 102(2)(C) of NEPA, 42 U.S.C. § 4332 (2)(C). [2/]

Presently before the Court is a motion pursuant to Rule 65, F.R.Civ.P., for a preliminary injunction restraining defendants[3] and their agents from transporting, or permitting the transportation by air of SNM from, to and over the United States and its territories, pending the determination of this action.[4]

I.

Consideration of whether the Court should grant the extraordinary remedy of preliminary injunction involves the analysis of three criteria -- likelihood of ultimate success on the merits, irreparable injury, and the balance of hardships. Sanders v. Air Line Pilots Association, International, 473 F.2d 244, 248-49(2d Cir. 1973), and cases cited therein; Heldman v. United States Lawn Tennis Association, 354 F.Supp. 1241, 1249-50 (S.D.N.Y. 1973).

These three elements are not considered separately but in combination, each weighed against the others. Sanders v. Air Line Pilots Association, International, supra at 248; Semmes Motors, Inc. v. Ford Motor Company, 429 F.2d 1197, 1205-06(2d Cir. 1970); Checker Motors Corp. Chrysler Corp., 405 F.2d 319, 323 (2d Cir.), cert. denied, 394 U.S. 999 (1969); Dino De Laurentis Cinematografica, S.p.A. v. D-150, Inc., 366 F.2d 373, 375 (2d Cir. 1966); Heldman v. United States Lawn Tennis Association, supra at 1250.

The movant bears "'the burden of demonstrating either a combination of probable success and the possibility of irreparable injury or that [it has] raised serious questions going to the merits and that the balance of hardships [tips] sharply in [its] favor.'" Pride v. Community School Board of Brooklyn, 482 F.2d 257, 264 (2d Cir. 1973), and cases cited therein. [5/]

There are thus two relevant factors to be considered: the movant's "possibilities of success on the merits" and the relative injuries occasioned by the issuance of the injunction, or its denial. Brown v. Chote, 411 U.S. 452, 456 (1973); Citizens for a Better Environment, Inc. v. Nassau County, 488 F.2d 1353, 1361 (2d Cir. 1973); Cohen v. Price Commission, 337 F.Supp. 1236, 1239 (S.D.N.Y. 1972), and cases cited therein. Assuming arguendo that plaintiff has shown a sufficient likelihood of ultimate success, I still must carefully weigh the consequences of granting or denying the injunction.

Plaintiff asserts that there are three bases upon which a preliminary injunction could properly issue in this case. First, it is argued that the failure to file an EIS is a violation of a clear, non-discretionary legal duty under

NEPA which constitutes irreparable harm per se. Second, plaintiff asserts that the continued shipment by air of SNM presents a substantially greater risk to human life than does the shipment of such material by surface transport. It is plaintiff's position that each air shipment of SNM carries with it the potential for irreparable harm. Finally, it is alleged that the balancing of the hardships weighs in favor of granting the preliminary injunction.

Irreparable harm per se

In arguing that a violation of NEPA, in and of itself constitutes sufficient irreparable harm to support the issuance of a preliminary injunction, plaintiff places principal reliance upon a series of NEPA cases decided in this circuit and others which at least arguably contain dicta to that effect. See, e.g., Environmental Defense Fund v. Tennessee Valley Authority, 468 F.2d 1164, 1184 (2d Cir. 1972); Scherr v. Volpe, 466 F.2d 1027, 1034 (7th Cir. 1972); Izaak Walton League of America v. Schlesinger, 337 F.Supp. 287, 295 (D.D.C. 1971). However, the courts involved have gone to considerable lengths to point out that 1) in the absence of injunctive relief actual, imminent, irreparable injury, such as the destruction of a forest or pollution of a river, would follow and/or 2) the impending Federal acts sought to be enjoined would render ineffectual any EIS which might ultimately be ordered.

For example, although the Court in Environmental Defense Fund v. Tennessee Valley Authority, supra at 1184, stated that,

> "[s]ufficient irreparable harm * * * can be found in the continuing denial by appellants of appellees' right under the NEPA, and this is enough to justify issuing the injunction,"

the Court had earlier observed that

> "plaintiffs alleged that they would suffer irreparable harm from the continuation of the construction activities of appellants that were permanently defacing the natural environment. Submitted along with this motion were affidavits * * * concerning activities of appellants such as the cutting and burning of timber, the movement of massive amounts of earth, the construction of large earthworks, and the relocation of roads and bridges. Plaintiffs' motion also referred to the condemnation of land and the resulting eviction of the former owners of the condemned properties. The District Court found that the activities relating to irreparable defacement of the environment were continuing, 339 F.Supp. at 808, and recognized that it had to consider the interest and injuries asserted by the parties, 339 F.Supp. at 812. Thus, the court clearly considered the allegations of irreparable harm made by plaintiffs as well as the harm that would allegedly result from issuing the injunction, and it concluded that the scales tipped in favor of plaintiffs. Plainly, the court found that plaintiffs would suffer irreparable harm if the injunction were not granted, and this finding is supported by the record."

Likewise, although the Court in Scherr v. Volpe, supra at 1034, did state that . . .

> "[t]he kind of 'irreparable harm' which must be shown in order to justify the issuance of a preliminary injunction in these cases can be found in the language of the Act [NEPA] itself",

it primarily based the granting of a preliminary injunction on the fact that if the challenged activity were allowed to proceed, the plaintiff's right to have the environmental consequences of the challenged project considered would be lost forever because in that case it would be impossible to return the affected area to its previous environmental status.

The objective of retaining the status quo was also considered significant in the Environmental Defense Fund case. 468 F.2d at 1183-84; see also Arlington Coalition on Transportation v. Volpe, 458 F.2d 1323, 1332-34 (4th Cir.), cert. denied, 409 U.S. 1000 (1972); Lathan v. Volpe, 455 F. 2d 1111, 1117 (9th Cir. 1971); Scherr v. Volpe, 336 F.Supp. 882, 886 (W.D.Wisc. 1971), aff'd, 466 F.2d 1027 (7th Cir. 1972).

Similarly, in Izaak Walton League of America v. Schlesinger, supra, if Judge Parker had not issued the preliminary injunction sought, the status quo would have been disturbed and it would have become difficult if not impossible to return the area to its previous condition.

Therefore, in the cases cited by plaintiff there was always some Federal action, such as the construction of a building or highway or the activating of a nuclear power plant,which could not be easily undone or changed. Thus it would be impossible or at least impracticable to make the modifications which might subsequently be indicated by an EIS. Judge Duniway in Lathan v. Volpe, supra at 1117,described such situations as

> "comparatively rare cases in which, unless the plaintiffs receive now whatever relief they are entitled to, there is danger that it will be of little or no value to them or to anyone else when finally obtained."

It is obvious that this case presents no such problem. To the contrary, in this case the Court is being asked to disturb the status quo by requiring defendants to alter a method of transporting SNM which has subsisted without any demonstrable adverse environmental impact for twenty-five years. This is not at all the same as enjoining the further construction of a road, clearing of a wilderness or degradation of a river.

Moreover, a denial of an injunction at this stage of the proceedings will in no way decrease the likelihood that there will be ultimate compliance with NEPA, nor render such compliance a hollow gesture, as would have been the situation in the other cases cited by plaintiff. For example, it would

be no more, or less, difficult to modify the regulations governing the transportation of SNM pursuant to the EIS which the NRC is scheduled to file next year whether I grant or deny plaintiff's request for a preliminary injunction.

I conclude that under the circumstances of this case it would be inappropriate to issue a preliminary injunction based solely on defendants' alleged violation of NEPA.

Risk to human life

Plaintiff contends that the continued air shipments of SNM endangers human life primarily in two ways:

1) the possibility of container rupture and resulting release of SNM caused by an air crash, and

2) the possibility of terrorist activities directed toward such shipments resulting in the hijacking of SNM and their threatened or actual dispersion into the atmosphere or theiruse in the manufacture of nuclear weapons.

Container rupture upon crash

Special nuclear materials are shipped in containers, the specifications for which are prescribed and approved jointly by the NRC, the Department of Transportation (DOT),

and the Federal Aviation Administration (FAA). It is uncontested that these containers are not invulnerable to all levels of crash stresses and common sense as well as the affidavits filed in this action attest to the fact that the containers would more likely be breached in the crash of an aircraft than that of a surface vehicle. This is of course due primarily to the generally higher speeds of aircraft which impose acceleration stresses much more severe than those experienced in collisions of surface vehicles.

Notwithstanding the above, the fact is that during the past twenty-five years, during which time all types of SNMs have been transported by commercial aircraft, there has never been an aircraft accident involving a release of SNM.[6/] Furthermore, even if an aircraft carrying SNM were to crash, due to the high integrity packaging required by the NRC, DOT and FAA regulations, the chances of encountering stresses capable of rupturing the SNM's container, in combination with the geographical, meteorological and other conditions required to produce the disastrous results envisioned by plaintiff, are extremely remote.

The hazard of an adverse incident due to an accidental air crash was further reduced last month when Congress severely limited the circumstances under which NRC licensees could ship plutonium by air. Plutonium is conceded by plaintiffs to be the only SNM which presents any real hazard to

human life in the event of an air crash. It is also significant that Congress now has a bill before it which would similarly, yet less drastically, restrict air shipments of plutonium by ERDA. On the basis of the record now before me, I can reach no conclusion except that the chances of an adverse environmental incident resulting from accidental air crash are much too small to warrant the issuance of an injunction pendente lite which would have unpredictable but possibly significant adverse effects in other respects discussed hereinafter.

Terrorist activities

Notwithstanding plaintiff's charge that civilian air shipments of SNM are susceptible to attack by terrorists, from the standpoint of vulnerability to terrorism, air transport has clear-cut advantages over surface transport. Not only does air transport lessen the time required for the shipment, but the only access to the shipment is before and after the flight, while a train or truck shipment is an exposed target at every point throughout its transit.

I am convinced that the increased possibility of hijacking involved in surface transport more than offsets any increased chance of accidental release which air transport may present. This is particularly so in the case of SNMs other than plutonium, which create no danger to human life even in the event of an air crash.

Plaintiff's claims both with respect to the dangers involved in the possibilities of air crashes and hijacking are based upon expert opinion which necessarily involved considerable conjecture, but which substantially ignored the attendant hazards of alternative forms of shipment of SNM.

The record does not establish a sufficient possibility of adverse environmental impact resulting from the continued air shipments of SNM to support plaintiff's allegations of irreparable injury or to warrant the issuance of a preliminary injunction.

Balancing the hardships

Finally, plaintiff has failed to demonstrate that the harm resulting from a denial of the injunction will outweigh the injury to defendants if the injunction is granted.

The affidavits submitted amply demonstrate that the public interest would not be served by a total ban on the shipment of SNM. Transport must continue in some mode. Aside from shipments to research projects and energy facilities in this country, the United States is a signatory on numerous agreements with foreign governments to supply at least part of their SNM needs. Therefore, granting a preliminary injunction at this stage would require defendants to alter significantly a method of transporting SNM which has proceeded for twenty-five years without incident.

Considering the extremely remote possibility of actual irreparable harm, combined with the fact that the continued air shipment of SNM will in no way reduce the effect that any EIS subsequently filed may have, as well as plaintiff's failure to convince the Court that air transportation of SNM involves greater overall hazards than surface transport leads me inexorably to the conclusion that a preliminary injunction should not issue.

The motion for a preliminary injunction is denied.

SO ORDERED.

William C. Conner
United States District Judge

Dated: New York, New York
September 9, 1975

FOOTNOTES

1. Special nuclear material (SNM) is defined in Section 11(aa) of the Atomic Energy Act of 1954, 42 U.S.C. § 2014(aa), as:

> "(1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 2071 of this title, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material."

The papers submitted in this action are addressed only to plutonium and uranium enriched in either of the isotopes 233 or 235.

2. 42 U.S.C. § 4332 provides, inter alia:

> "The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this chapter, and (2) all agencies of the Federal Government shall --
>
> * * * *
>
> (C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on--
>
> (i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemente .

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."

3. Defendant Nuclear Regulatory Commission's (NRC) functions include licensing possession and transportation of SNM and developing and enforcing standards for containers in which SNM is transported.

Licenses issued by the NRC authorize the licensee to receive, possess and use the radioactive materials specified in the license. They also provide authority for the licensee to effect the delivery and transfer of such material to an authorized recipient. The NRC does not specify the mode of transport to be used by licensees.

The actual carriers of SNMs are not licensed by the NRC but rather by some different federal agency such as Interstate Commerce Commission or Federal Aviation Agency (FAA). For example, the University of Michigan would need an NRC license before it could possess or ship SNM to the University of Nebraska, but such material could be carried by air only by a carrier licensed to transport hazardous materials by the FAA.

With the exception of defendant Energy Research and Development Administration (ERDA), and the Department of Defense, no person may possess SNM unless licensed by the NRC or a State, such as New York, which has entered into an agreement with the NRC pursuant to Section 274 of the Atomic Energy Act of 1954, 42 U.S.C. § 2021.

Defendant Department of Transportation (DOT), has overlapping responsibility with the NRC for reviewing and developing safety standards governing the handling and

storage of SNM while in the possession of a common, contract or private carrier. Defendant FAA, a branch of the DOT, has similar overlapping responsibility for such safety standards as they involve transportation of SNM by commercial passenger or cargo aircraft.

NRC regulations respecting the possession and transportation of SNM appear in 10 C.F.R. Parts 20, 70, 71 and 73. DOT provisions regulating the handling and shipment of hazardous materials appear at 49 C.F.R. Parts 170 through 179 and 46 C.F.R. Part 146. FAA regulations are at 14 C.F.R. Part 103.

The remaining defendants do not regulate the possession or transportation of SNM by others. Defendant ERDA is responsible for, among other things, production of SNM at its facilities and for research in which SNM are used. It operates various facilities, such as the former Atomic Energy Commission's (AEC) gaseous diffusion plants in Oak Ridge, where uranium is enriched, and the Brookhaven National Laboratory on Long Island, where nuclear research is conducted. ERDA is also responsible for the manufacture and delivery to the Department of Defense of nuclear weapons.

Accordingly, ERDA itself makes or arranges for domestic shipments of SNM between its various plants and laboratories and between Department of Defense installations, as well as between commercial fuel fabricators and independent research centers. Most of ERDA's shipments relate to defense programs of the United States, such as shipments of weapons components and materials and fuels connected with the naval reactor program.

ERDA is also responsible for administering Agreements of Cooperation which are negotiated by defendant Department of State and approved by Congress. International shipments of SNM by ERDA are, for the most part, pursuant to these Agreements.

While ERDA is not required to obtain a license from the NRC to ship SNM, the commercial carriers it uses must be certified by other Government agencies, such as the FAA, and must meet all applicable Federal and international safety requirements.

Defendant Civil Aeronautics has no direct involvement in regulating SNM because it does not license the carriage of any particular cargo. The only involvement of defendant United States Customs Service is to ensure that SNM enter or leave the United States only if the

shipper has a valid license issued by the NRC or qualifies for one of the specific exemptions from the licensing requirements as established by NRC regulations.

4. Since its organization in January of this year, the NRC has stated its intention of reviewing its regulations, which were originally promulgated by the AEC, pertaining to the licensing and regulation of nuclear facilities and materials. As part of that review, the NRC announced prior to the commencement of this action that it would prepare an EIS concerning the transportation of radioactive material, including SNM, by air and by alternative means. It also announced that it would conduct a rule making proceeding concerning the transportation of radioactive material, including SNM, to determine if there should be any changes in existing applicable regulations or modes of transportation.

   Formal notice of both the EIS and the rule making proceeding was published in the Federal Register on June 2, 1975. 40 Fed. Reg. 23768. It has been represented to the Court that a draft of the EIS will be available for public comment by the end of this year and the final version by the summer of next year. The Federal Register notice invited persons to submit information, comments and suggestions as to whether radioactive material should continue to be transported by air and, if so, whether and what improvements in applicable regulations are necessary.

5. Although some of the cases cited speak in terms of "possible" irreparable injury, surely the mere fact that one can conceive of a series of events and speculate as to their possible occurrence, regardless of how remote, is not a sufficient basis upon which to conclude that a preliminary injunction should issue. See Cohen v. Price Commission, 337 F.Supp. 1236, 1239 (S.D.N.Y. 1972).

6. Between 1970 and 1973, United States carriers flew 12,610,995,000 miles with only 112 accidents in which aircraft received substantial damage or were destroyed. Cargo aircraft, which carry all shipments exceeding

twenty curies of SNM, were involved in a total of only six accidents from 1970 through 1973.

Of the 112 accidents referred to, eighty-two aircraft were "substantially" damaged and thirty were "destroyed." The National Transportation and Safety Board (NTSB), which compiled these figures, defines substantial damage to mean damage or structure failure which adversely affects the structural strength, performance or flight characteristics of an aircraft and which would normally require major repair or replacement of the affected component. The NTSB considers an aircraft to be totally destroyed when the damage is so extensive as to be beyond repair.

Whether in either case there would be damage to cargo depends upon a significant number of variables including location of the cargo within the plane, the velocity and angle of impact, the energy absorbed by strain or rupture of the airplane, and the residual stress transmitted to the cargo. For example, an aircraft which requires a major repair to an engine when its landing gear collapses upon the runway would be classified by the NTSB as being substantially damaged. However, it is unlikely that such an accident would endanger any of its cargo. Even when an aircraft is totally destroyed for purposes of these statistics, it cannot be assumed that all of its cargo will be destroyed with it.

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK,

Plaintiff,

-against-

The Nuclear Regulatory Commission, and WILLIAM ANDERS as Chairman; the Energy Research and Development Administration and DR. ROBERT C. SEAMANS as the Administrator; the Department of Transportation, and WILLIAM T. COLEMAN as Secretary of Transportation; the Department of State and HENRY A. KISSINGER as Secretary of State; the Civil Aeronautics Board and ROBERT D. TIMM as the Chairman; the Federal Aviation Administration and ALEXANDER P. BUTTERFIELD as the Chairman; the United States Custom Service and VERNON B. ACREE as Commissioner and FRED R. BOYETT as Regional Commissioner,

Defendants.

NOTICE OF APPEAL

75 Civ. 2121 (WCC)

Notice is hereby given that the State of New York, plaintiff in the above-captioned action, hereby appeals to the United States Court of Appeals for the Second Circuit from the order of the Honorable William C. Conner, United States District Judge entered in this action on the 9th day of September, 1975, which order denied in all respects the motion of the State of New York for preliminary injunctive relief.

LOUIS J. LEFKOWITZ
Attorney General of the
State of New York
Attorney for Plaintiff-Appellant
By

JOHN F. SHEA, III
Assistant Attorney General

TO: THOMAS J. CAHILL
United States Attorney for
the Southern District of
New York
Annex
St. Andrew's Plaza
New York, New York

FILED Nov. 7, 1975

NLG:sm
75-1672

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK,

Plaintiff,

-v-

THE NUCLEAR REGULATORY COMMISSION, et al.,

Defendants.

NOTICE OF MOTION

75 Civ. 2121 (MCC)

PLEASE TAKE NOTICE that upon the annexed memorandum of law and upon all prior proceedings, defendants, the United States Civil Service Commission and the United States Customs Service will move this Court in the United States Courthouse, Room 3006, Foley Square, New York, New York on August 28, 1975 at 10:00 o'clock in the forenoon for an order pursuant to Rule 12(b) of the Federal Rules of Civil Procedure dismissing the complaint with respect to said defendants on the ground that it fails to state a claim upon which any relief can be granted or with respect to the United States Civil Service Commission, over which this Court has jurisdiction.

Dated: New York, New York
August 15, 1975.

Yours, etc.,

PAUL J. CURRAN
United States Attorney for the
Southern District of New York
Attorney for Defendants.

By: _____
NATHANIEL L. GREBER
Assistant United States Attorney
Office and Post Office Address:
One St. Andrew's Plaza
New York, New York 10007
Telephone: (212) 791-1946

914

NLG:sm
75-1672

TO: JOSEPH J. ZEDROSSER
Assistant Attorney General
Department of Law
State of New York
Two World Trade Center
New York, New York 10047

915

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT, NEW YORK

THE STATE OF NEW YORK,

Plaintiff,

-against-

THE NUCLEAR REGULATORY COMMISSION, et al.,

Defendants.

AFFIDAVIT

75 Civ. 2121 (WCC)

JOHN F. SHEA, III, being duly sworn deposes and says:

I am an Assistant Attorney General in the Environmental Protection Bureau of the New York State Deppartment of Law. I make this affidavit in opposition to the motion of the Civil Aeronautics Board and the United States Custom Service to dismiss the complaint against them.

It is contended that the arguments put forth by the defendants are wholly without meric for the reasons set forth in the accompanying Memorandum of Law. Accordingly, it is respectfully requested that the motion of the defendants be denied in all respects.

JOHN F. SHEA, III

Sworn to before me this
5th day of September, 1975

Assistant Attorney General
of the State of New York

916

UNITED STATES OF AMERICA
CIVIL AERONAUTICS BOARD
WASHINGTON, D. C.

Adopted by the Civil Aeronautics Board
at its office in Washington, D. C.
on the 14th day of June, 1974

Non-acceptance of restricted articles in containers by DELTA AIR LINES, INC. THE FLYING TIGER LINE INC. UNITED AIR LINES, INC.	Docket 26616 26617 26768 26774 26778 26784
Non-acceptance of Fissile Class III radioactive material proposed by TRANS WORLD AIRLINES, INC.	

ORDER

By Order 74-5-15, dated May 3, 1974, the Board dismissed complaints of the Council for Safe Transportation of Hazardous Articles (COSTHA) in Docket 26617 and of Shulman Air Freight, Inc., in Docket 26616, relating to a tariff rule 1/ filed by The Flying Tiger Line Inc. (Tiger), which provided that all articles subject to the Restricted Articles Tariff 2/ will not be accepted in containers listed in the container tariff and that, if tendered as part of a containerized shipment, such articles will be accepted only as outside pieces, but at no increase in rates.

On May 20 and 22, respectively, petitions for reconsideration of Order 74-5-15 were filed by the Department of Transportation (DOT) and COSTHA. Petitioners contend in substance that, in accepting Tiger's tariff and permitting the rule to become effective, the Board exceeded its jurisdiction. DOT states:

> "It is the responsibility and duty of the Department of Transportation/Federal Aviation Administration ("DOT/FAA") to prescribe rules and regulations necessary to provide for safety in air commerce under Title VI of the Federal Aviation Act of 1958, as amended (49 U.S.C. 1421 et seq.). Pursuant to that authority and responsibility, Part 103 was promulgated

1/ Rule 65, Airline Tariff Publishers, Inc., Agent, Tariff C.A.B. No. 82.
2/ Airline Tariff Publishers, Inc., Agent, Tariff C.A.B. No. 82.

by the FAA and prescribes rules for loading and carrying dangerous articles and magnetized materials in civil aircraft. Part 103 now authorizes containerized shipments of dangerous articles aboard aircraft within safety limitations therein set forth. While the FAA recently published for public comment a notice of proposed rulemaking 1/ proposing certain changes in Part 103, DOT/FAA does not have any information which would justify an embargo of containerized shipments of dangerous articles on safety grounds.

1/ 39 Fed. Reg. 14612 (Apr. 25, 1974)."

DOT and COSTHA filed complaints requesting rejection, or in the alternative, suspension of similar rules filed by Delta Air Lines, Inc. (Delta) and United Air Lines, Inc. (United) for effectiveness June 23 and June 27, respectively, upon substantially the same grounds as set forth in their petitions for reconsideration. Tiger filed a consolidated answer to both petitions for reconsideration contending, inter alia, that there is no specific requirement in FAA's regulations that a carrier must accept hazardous articles in containerized shipments; that if the carrier had to break down containerized shipments for inspection, the economic basis for containerization would be lost; and that its rule imposes no rate penalty.

The pleadings herein raise fundamental questions regarding the respective jurisdictions of the Board and the DOT/FAA, with respect to carrier tariff provisions which are premised upon safety considerations. While we are not prepared to resolve these questions definitively at this time, we accept in principle the statement of DOT concerning its responsibility and duty. Further, our own regulations, Section 221.38(a)(5), provide that tariff rules relating to the transportation of explosives and other dangerous or restricted articles shall be in conformity with Part 103 of the Federal Aviation Regulations. It would thus appear that there is a basis for rejecting Tiger's effective rule if it is not in conformity with such regulations. 2/ In these circumstances, the Board will grant the petitions for reconsideration. We shall, however, for the reasons stated below, defer taking action at this time upon the requests for rejection. 3/ We have considered the fact that Tiger's tariff rule is in effect following the Board's

2/ The Board has consistently considered that it may order cancelled tariffs in conflict with applicable law or regulations, and that such tariffs are subject to rejection. E.g., see Order E-18449, dated June 14, 1962; Order E-18640, dated July 27, 1962; Order 71-8-78, dated August 17, 1971, and Order 72-6-7, dated June 2, 1972.

3/ Inasmuch as Tiger's tariff is in effect, we shall deny the requests for suspension of that filing.

dismissal of complaints thereto. While this does not, per se, preclude rejection of Tiger's proposal, the Board has not heretofore been presented with the contention of DOT in a complaint proceeding that tariff regulations involving hazardous materials or safety matters must first be adopted in substance by DOT/FAA before being filed or accepted as tariff material.5/ DOT, in its complaints, refers to FAA's recent publication for public comment of a notice of proposed rulemaking proposing certain changes in Part 103. DOT notes that whether noncontainerized shipments of dangerous articles pose a greater hazard due to the additional handling which would be involved in such shipments is a matter open for public comment in the proposed rulemaking action. For example, DOT's complaint against Delta's proposal states:

> "If the Board or Delta has information indicating a need for a rulemaking on containerized air shipments of dangerous articles, this information should be submitted to DOT/FAA for appropriate rulemaking action applicable uniformly throughout the industry. In the absence of this information, we question whether an embargo of containerized shipments of dangerous articles can be justified on safety grounds. We express no opinion, however, on whether the proposal may be justified on other grounds."

The FAA has granted until August 31, 1974, for public comment upon its rulemaking proposal.

In this situation,6/ and in view of the fact that Tiger's rule does not preclude the transportation of any material, but only the manner in which it is tendered, we shall defer final action on reconsideration to allow the carrier to pursue its remedy with FAA in the rule-making proposal above noted. Since the proposals of Delta7/ and United8/ are the same as Tiger's filing, we shall in the same manner deny the requests for suspension and defer action upon the requests for rejection to give these carriers the same opportunity to urge revisions of Part 103.9/

5/ The Board administers its regulations to require tariff rules to be in conformity with Part 103.

6/ The House Commerce Committee's special subcommittee on investigations has recently been holding extensive hearings on this subject. The National Transportation Safety Board has also had occasion to consider recommendations in this area.

7/ Airline Tariff Publishers, Inc., Agent, Tariff C.A.B. No. 131.

8/ Airline Tariff Publishers, Inc., Agent, Tariff C.A. No. 212.

9/ We shall also, at that time, review the carriers' [illegible] tariffs for their conformance with DOT's regulations.

We shall, however, reject a tariff revision proposed by Trans World Airlines, Inc. (TWA) bearing the issue date of May 16 and marked to become effective June 15, 1974,[10] refusing to accept Fissile Class III materials.[11] TWA asserts, inter alia, that shipments of such materials are so potentially hazardous that such articles should not be transported, and continued acceptance would be "counterproductive to safety." No complaints were filed. The carrier's present tariff, in general conformity with DOT regulations, indicates the manner in which fissile materials in various classes are to be packed and shipped,[12] and we believe that TWA's common carrier responsibilities require that the airline accept such shipments under those conditions. We distinguish this rejection from the deferral of such action for the non-acceptance of containerized shipments by Tiger, Delta, and United in view of the fact that TWA's proposal involves a complete refusal to accept certain restricted articles in direct contravention of its obligation to carry. On the other hand, Tiger's effective tariff, and the similar tariff proposals by Delta and United, involve only the non-acceptance of restricted articles in containerized form, but permit acceptance of outside pieces at the same transportation charge as if the articles were containerized.

10/ Revisions to Airline Tariff Publishers, Inc., Agent, C.A.B. No. 82.

11/ According to Section VI of the above tariff, "Fissile materials consist of radionuclides such as Uranium 233 and 235 and Plutonium 238, 239, and 241, the atoms of which are capable of being split by neutrons to release energy in the form of heat, gamma radiation, and further neutrons."

12/ The tariff currently provides that:

> "A. Fissile Class III packages shall be transported only under special arrangements. Such arrangements may require exclusive use of the aircraft or a compartment, separation from certain other materials, accompanied by a qualified attendant, or other special conditions. These may be carried on cargo only aircraft which has been assigned for the sole use of the consignor or on any aircraft on which there are no other packages or radioactive material required to bear a radioactive label.
>
> B. Prior arrangements shall be made with each carrier involved.
>
> C. When other materials must not be shipped with Fissile Class III packages, a specific restriction shall be provided in the special arrangement and an instruction to that effect issued with the transport documents."

Accordingly, pursuant to the Federal Aviation Act of 1958, and particularly Sections 204(a) and 403(a) thereof,

IT IS ORDERED THAT:

1. The petitions for reconsideration of Order 74-5-15 filed by the Department of Transportation and the Council for Safe Transportation of Hazardous Articles in Dockets 26616 and 26617 are granted. The requests for suspension contained therein are denied and action upon the requests for rejection is deferred until further order by the Board;

2. The complaints filed by the Department of Transportation in Dockets 26774 and 26784, and by the Council for Safe Transportation of Hazardous Articles in Dockets 26768 and 26778 are denied as to suspension. Action upon the requests for rejection is deferred until further order by the Board;

3. 15th Revised Page 48, 7th Revised Page 142, and 8th Revised Page 160-D of Airline Tariff Publishers, Inc., Agent's C.A.B. No. 82 be and hereby are rejected; and

4. Copies of this order shall be served upon Airline Tariff Publishers, Inc., The Flying Tiger Line Inc., Delta Air Lines, Inc., Trans World Airlines, Inc., United Air Lines, Inc., The Council for Safe Transportation of Hazardous Articles, Shulman Air Freight, Inc., and the Department of Transportation.

By the Civil Aeronautics Board:

EDWIN Z. HOLLAND
Secretary

(SEAL)

memo decision + Order

0081

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

- X

THE STATE OF NEW YORK,

Plaintiff,

- against -

The Nuclear Regulatory Commission, and WILLIAM ANDERS as Chairman; the Energy Research and Development Administration and DR. ROBERT C. SEAMANS as the Administrator; the Department of Transportation, and WILLIAM T. COLEMAN as Secretary of Transportation; the Department of State and HENRY A. KISSINGER as Secretary of State; the Civil Aeronautics Board and ROBERT D. TIMM as the Chairman; the Federal Aviation Administration and ALEXANDER P. BUTTERFIELD as the Chairman; the United States Customs Service and VERNON B. ACREE as Commissioner and FRED R. BOYETT as Regional Commissioner,

Defendants.

- X

75 Civ. 2121
(WCC)

MEMORANDUM
AND ORDER

#43591

U.S. DISTRICT COURT
FILED
DEC 23 1975
S. D. OF N. Y.

CONNER, D. J.:

Defendants the Civil Aeronautics Board (CAB) and the United States Customs Service (Customs) have moved, pursuant to Rule 12(b) F.R.Civ.P., to dismiss so much of the complaint in the above-captioned action as is directed against them. Both of the moving defendants assert that, as to them, the complaint fails to state any claim upon which relief might be granted. The CAB moves, in the alternative, to dismiss as to it on the ground that this Court does not have jurisdiction to entertain the claims presently brought against the CAB.

I.

The underlying action is grounded upon alleged violations of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. § 4321 et seq. Plaintiff charges that defendants have unlawfully ignored NEPA's mandate by causing or permitting the air transport of special nuclear materials (SNM) without the prior issuance of an environmental impact statement (EIS) pursuant to Section 102(2)(C) of NEPA, 42 U.S.C. § 4332(2)(C).[1/]

II.

The CAB and Customs argue that their respective functions in connection with the shipment by air of SNM do not allow for, or constitute, the type of agency action that is subject to NEPA's procedural strictures. Both the CAB and Customs contend that, under statutory directives, the authority for licensing, allocation, and safety regulation of air carriage of SNM rests squarely with defendants the Nuclear Regulatory Commission (NRC), the Energy Research and Development Administration, and the Department of Transportation/ Federal Aviation Administration (DOT/FAA) and that their own involvement in the regulation of SNM is entirely peripheral.

In response, plaintiff asserts that the following activities, concededly undertaken by either the CAB or Customs,

or both, render each of the moving defendants subject to Section 102(2)(C) of NEPA:

> "1) Customs permits the entry into the United States of air transported SNM * * * .
>
> 2) The CAB grants certificates of convenience and necessity and passes on tariff applications * * * .
>
> 3) The promotion of air safety is a policy of the CAB [pursuant to the directive of Section 102 of the Federal Aviation Act, 49 U.S.C. § 1302] * * * .
>
> 4) The CAB and Customs assure compliance with DOT/FAA or NRC regulations * * * .
>
> 5) The CAB and Customs assure that air carriers have valid NRC licenses or qualify for an exemption pursuant to NRC regulation * * * ." Plaintiff's Brief at 4.

III.

A basic appreciation of the intended function of an EIS serves as the proper measure of plaintiff's arguments herein. As noted in the guidelines of the Council for Environmental Quality, Section 102(2)(C) of NEPA

> "requires agencies to build into their decisionmaking process * * * an appropriate and careful consideration of the environmental aspects of proposed action in order that adverse environmental effects may be avoided or minimized and environmental quality previously lost may be restored." 40 C.F.R. § 1500.1(a) (emphasis added).

Just as "[p]ro forma compliance" with the procedural directives of NEPA "will not suffice," where compliance with those directives

is appropriate, Scherr v. Volpe, 466 F.2d 1027, 1031 (7th Cir. 1972), the issuance of an EIS by an agency with respect to an action that does not in fact or effect involve that agency's own decisionmaking would be an empty ritual hardly required by NEPA.

Pared down to its essentials, the instant complaint charges the CAB and Customs with, at most, the enforcement of directives from other agencies that are statutorily responsible for regulation of the licensing and safe air transport of SNM. Such enforcement scarcely allows for the element of decisionmaking upon which the EIS requirement is bottomed. In this connection, dictum from a recent Second Circuit opinion is particularly instructive. Referring to regulations promulgated by DOT/FAA, the Court observed that,

> "There are rules which apply to the carriage of hazardous materials, and it is implicit in these rules that such goods, marked, labelled, packaged and stowed in accordance with such rules, are not inimical to flight safety in the judgment of the agencies charged by the Congress with the responsibility of making these determinations. Individual carrier or pilot decision [departing from the DOT/FAA regulations] could only lead to administrative chaos * * * ." Air Line Pilots Association, International v. CAB, 516 F.2d 1269, 1276 (2d Cir. 1975).

Departure from DOT/FAA regulations by sister agencies -- even if only by a failure or refusal to enforce those regulations -- would have the same result. Thus, in requiring carriers and shippers to conform to the rules of the NRC or

DOT/FAA, the CAB and Customs necessarily do so as a matter of course, not as a consequence of their own deliberation and discretion, so that there is no potential collision with the authorized determinations of other agencies.

For the reasons set forth above, defendants' motion to dismiss those portions of the complaint that are directed against them is granted.

SO ORDERED.

WILLIAM C. CONNER
United States District Judge

Dated: New York, New York
December 23, 1975

926

FOOTNOTE

1. In relevant part, Section 102(2)(C) provides:

> "The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this chapter, and (2) all agencies of the Federal Government shall --
>
> * * * *
>
> (C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the repsonsible official on --
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> (i) the environmental impact of the proposed action,
>
> (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
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> (iii) alternatives to the proposed action,
>
> (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
>
> (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

THE STATE OF NEW YORK,

Plaintiff,

- against -

The Nuclear Regulatory Commission, and WILLIAM ANDERS as Chairman; the Energy Research and Development Administration and DR. ROBERT C. SEAMANS as the Administrator; the Department of Transportation, and WILLIAM T. COLEMAN as Secretary of Transportation; the Department of State and HENRY A. KISSINGER as Secretary of State; the Civil Aeronautics Board and ROBERT D. TIMM as the Chairman; the Federal Aviation Administration and ALEXANDER P. BUTTERFIELD as the Chairman; the United States Custom Service and VERNON B. ACREE as Commissioner and FRED R. BOYETT as Regional Commissioner,

Defendants.

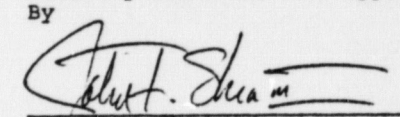
NOTICE OF APPEAL

75 Civ. 2121 (WCC)

Notice is hereby given that the State of New York, plaintiff in the above-captioned action, hereby appeals to the United States Court of Appeals for the Second Circuit from the order of the Honorable William C. Conner, United States District Judge, entered in this action on the 23rd day of December, 1975, which order dismissed the complaint as to defendants Civil Aeronautics Board and the United States Customs Service.

Dated: New York, New York
February 3, 1976

LOUIS J. LEFKOWITZ
Attorney General of the
State of New York
Attorney for Plaintiff-Appellant
By



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928